VOLUME 15, NO. 12
DECEMBER 1983

THE SHOCK AND VIBRATION DIGEST

A PUBLICATION OF
THE SHOCK AND VIBRATION
INFORMATION CENTER
NAVAL RESEARCH LABORATORY
WASHINGTON, D.C.

OFFICE OF
THE UNDER
SECRETARY
OF DEFENSE
FOR RESEARCH
AND
ENGINEERING

Approved for public release; distribution unlimited.

THE SHOCK AND VIBRATION DIGEST

Volume 15, No. 12
December 1983

STAFF

BOARD OF EDITORS

The Shock and Vibration Digest is a monthly publication of the Shock and Vibration Information Center. The goal of the Digest is to provide efficient transfer of sound, shock, and vibration technology among researchers and practicing engineers. Subjective and objective analyses of the literature are provided along with news and editorial material. News items and articles to be considered for publication should be submitted to:

Dr. R.L. Eshleman
Vibration Institute
Suite 206, 101 West 55th Street
Clarendon Hills, Illinois 60514
(312) 654-2254

Copies of articles abstracted are not available from the Shock and Vibration Information Center (except for those generated by SVIC). Inquiries should be directed to library resources, authors, or the original publishers.

This periodical is for sale on subscription at an annual rate of $140.00. For foreign subscribers, there is an additional 25 percent charge for overseas delivery on both regular subscriptions and back issues. Subscriptions are accepted for the calendar year, beginning with the January issue. Back issues are available - Volumes 9 through 14 - for $20.00. Orders may be forwarded at any time to SVIC, Code 5804, Naval Research Laboratory, Washington, D.C. 20375. Issuance of this periodical is approved in accordance with the Department of the Navy Publications and Printing Regulations, NAVEXOS P-35.

A publication of

THE SHOCK AND VIBRATION
INFORMATION CENTER

Code 5804, Naval Research Laboratory
Washington, D.C. 20375
(202) 767-2220

SVIC NOTES

THE MIL-STD-810D SESSIONS AT THE 54th SHOCK AND VIBRATION SYMPOSIUM

If attendance is any measure of the success of technical sessions at meetings, then the two sessions on MIL-STD-810D must have been successful because both were well attended. Before briefly reviewing these sessions, I wish to thank all authors, the panelists, the cochairmen, and the chairmen for their contributions to these sessions. Special thanks are due to Dr. Sheldon Rubin for suggesting that this standard should be discussed at this symposium. Special thanks are also due to Mr. Eli Lesser of the Defense Material Specifications and Standards Office for his help in securing enough copies of MIL-STD-810D for distribution at the meeting. Their availability certainly helped generate interest in both of these sessions.

To summarize the content of these sessions, the morning session concerned the rationale behind MIL-STD-810D. Its chairmen and cochairmen were John Wafford of the Aeronautical Systems Division and Bob Hancock from the Vought Corporation. In that session Dr. Sheldon Rubin from the Aerospace Corporation described the changes in the shock testing procedures. A presentation coauthored by David Earls, Dr. Alan Burkhard and Scott Hall, all from the Wright Aeronautical Laboratories, described the overall impact of MIL-STD-810D on the environmental testing process; David Earls made this presentation. The session was concluded with a contributed paper by Henry Caruso and Edward Szymkowiak of the Westinghouse Electric Corporation on the response of Line Replaceable Units to bench handling shock; Edward Szymkowiak made the presentation.

I was capably assisted by Wallace Parmenter from the Naval Weapons Center in chairing the afternoon session. This session dealt with the implementation and the use of MIL-STD-810D, and it included formal presentation followed by a panel discussion. Howard Allen from the Rockwell International Corporation made the first presentation, and he described their experiences in developing vibration test criteria for Apollo and Space Shuttle Equipment. Harry Himelblau, also from the Rockwell International Corporation, and Marion Coody were his coauthors. Dr. Allen Curtis from Hughes Aircraft Company discussed the impact of MIL-STD-810D on laboratory shock and vibration test procedures. Jack Robinson from the Army Test and Evaluation Command served on this panel along with the authors of the invited papers.

To conclude, space does not permit the discussion of the many extensive changes to this version of MIL-STD-810D. Overall, this document is more flexible because it provides for tailoring test conditions to specific platforms, and many of its test methods permit low level tests to be deleted if it is known that the equipment will be exposed to similar tests that are more severe. However, this increased flexibility in this standard is provided at the cost of requiring environmental engineering expertise to intelligently apply its provisions for developing realistic environmental test criteria.

R.H.V.

EDITORS RATTLE SPACE

THE COMPUTER REVOLUTION

This issue of the **Digest** is a milestone; it marks the end of the fifteenth year of publication of the **Digest.** It seems appropriate to reflect on the impact of significant changes that have been reported in it. The past 15 years have witnessed enormous advances that have affected and will continue to affect the way we do engineering. It can be said that the quality and cost effectiveness of engineering have improved; it can also be said that these improvements have not always resulted in better problem solution or engineering judgment.

The greatest single influence on engineering during these 15 years has been the digital computer. Its tireless power in using numerical algorithms with efficiency and speed to solve differential equations, to perform graphics, and to store and retrieve data has revolutionized the entire engineering field. It is true that mainframe computers were popular 15 years ago, but few engineers had access to them, nor did they completely trust working problems on them.

The power of the mainframe computer of the 1960s is now available in the desktop microprocessor, and the computer hardware now avilable can be used by virtually all engineers. The microprocessor is the basis for test control, FFT analysis, data storage and manipulation, and logic in problem determination.

On the other hand, the capability of the mainframes has also been extended by orders of magnitude and now provides the means for solving problems that had not even been formulated in the 1960s. Computer hardware has provided increased capability not only in modeling through mathematics but also in testing.

What about the future? In my opinion the computer will continue to dominate advances in engineering for the next 15 years and beyond. However, it will be a software revolution -- not a hardware one. The minor advances that will be made in hardware will increase computing power and lower microprocessor costs. More important will be the order-of-magnitude advances that will be made in software; they will enable us to utilize the computing power we already have available. This user-oriented software will provide the capability to solve larger sets of equations, to manage and analyze data, and to control processes and tests. In other words, user-oriented software will increase the efficiency and cost effectiveness of engineering and will allow more efficient hardware development, problem diagnosis, and equipment evaluation.

There is a pitfall in all of our computer capability, however. And it is the possibility that we will allow the computer to become the black box of engineering. The temptation will be great to rely increasingly on the computer because computation makes engineering appear easier. However, computation cannot replace the creative aspects of engineering -- problem formulation, conceptual design, and evaluation. We must not allow the computer to replace the art of engineering.

R.L.E.

VEHICLE-STRUCTURE INTERACTIONS IN BRIDGE DYNAMICS

E.C. Ting* and M. Yener**

Abstract. A great amount of literature exists on dynamic interaction problems concerning guideways and moving vehicles. Because of the mathematical difficulties introduced by the coupling terms in the behavioral governing differential equation, the transverse inertia effect of a moving vehicle is often neglected. With the improved availability of advanced computer methods and facilities, it has become possible to take into account the kinematics of the interaction problem. In this article recent developments in analytical and numerical approaches for solving vehicle-guideway interaction problems are discussed; related recent literature is cited. In addition, recently reported relevant experimental developments are presented.

This is the third literature review on the dynamic interactions between guideway structures and traversing vehicles. The first article [1] contained a discussion of the evolution of the vehicle-guideway interaction problems. The mathematical difficulties introduced by the mixed derivative and coupling terms arising in the formulation were emphasized. Different types of structures and operating conditions of the traversing vehicles, for which solutions of the associated boundary problems have been studied, were reviewed. Summaries of the classical modal superposition technique for closed form solutions and the structural impedance approach for numerical solutions were also discussed.

As noted in a previous article [2], in order to avoid the mathematical difficulties introduced by the mixed derivatives, simplifying assumptions are commonly made for the purpose of obtaining closed form solutions. A traditional approach is to ignore the coupling effect entirely. This approach physically corresponds to neglecting the effect of the vertical inertia of the moving vehicle. Separate responses for vehicle and guideway are often considered as opposed to treating the vehicle-guideway as a combined system. As a consequence of considering separate responses, which is commonly referred to as the moving force approximation, classical analytical methods of modal expansion and linear transformation techniques can be employed.

Advanced computational methods are used to circumvent mathematical difficulties and eliminate extreme approximations in modeling vehicle-guideway interactions. Direct time integration approaches are usually used; an advantage is that versatile structural computational methods, such as matrix analysis and finite element method, can easily be incorporated into the solution. These approaches are relatively simple to apply and are not restricted to specific guideway configurations and vehicle operating conditions. Despite such recent developments, most of the work reported in the literature reflects the traditional approach. The majority of studies are attempts either to extend the sophistication of field equations or to include more complex forcing functions and boundary conditions.

A previous article in this series [2] also provided an updated literature review concerning solution procedures for moving force approximation, moving mass approximation, and massless guideway approximation. Massless guideway approximation can provide adequate predictions for problems involving large vehicle mass-to-guideway mass ratios. An example of such a case is a cable car traversing a taut cable. Contrary to the conventional low, constant velocity assumption, the vehicle moves at a high velocity that varies as a function of time.

As has been noted in the previous reviews [1, 2], sufficient justification exists to use the moving force approximation by neglecting vehicle-guideway interactions, provided the consequences of its limitations are recognized. The simplification has been shown to

*Professor of Civil Engineering, Purdue University, West Lafayette, IN 47907
**Assistant Professor of Civil Engineering, Purdue University, West Lafayette, IN 47907

be an accurate model for systems with small vehicle-guideway mass ratios or for vehicles traversing at a low, constant speed over simple structures, such as a single span beam. However, for vehicles traveling at variable speeds and for complex structural configurations, in which numerical approaches are often required for solutions, the moving force simplification appears to be questionable considering its inaccuracy and limited application.

RECENT DEVELOPMENTS

Moving force approximation. Most recent studies represent extensions of traditional moving force approaches. A considerable amount of work concerns structures with complex geometry. Hayashikawa and Watanabe used modal analysis to study the dynamic response of continuous beams [3] and suspension bridges [4] due to a moving force with constant speed. Similar approaches were employed [5] for bridges with an orthotropic slab deck and a box girder deck. The Laplace transformation was used [6] for a plate strip of infinite length with elastic supports.

Similar studies for supporting guideways other than bridge structures have also been reported. For example, Beltaos [7] considered the response of floating ice sheets due to moving loads; interesting field measurements for the effect of vehicle speed were included. An annular disk [8], viscoelastic cylindrical shells [9], and a fluid-filled cylindrical shell [10] have been considered, as have an elastic strip moving across a rigid step [11] and a moving load on an elastic beam resting on an elastic half plane [12]. The response of an elastic membrane to a traveling ring load has also been studied [13].

A significant recent advancement is the study of variable speed. Analyses generally rely heavily on numerical procedures for complete solutions although modal expansion remains the prevailing technique for separating time and space variables. Susuki [14] considered a finite beam subjected to a force with initial velocity and constant acceleration. Effects of vehicle braking coupled with surface irregularities were considered for more authentic modeling of highway bridges [15-17].

Efforts have been made to obtain more precise models for moving force problems. Approaches that include the dynamic heave response of high-speed vehicles have been formulated by considering vehicle suspension systems. Although the inclusion of suspension systems complicates the analysis, the basic formulations remain linear and uncoupled. As a consequence, modal analysis has been successfully used as a solution method. The response of vehicles traveling on a flexible guideway with irregular surface configuration has been studied [18, 19].

Skew bridge decks [20] and circular decks [21] have been considered. Literature concerning the inadequacy of treating the bridge as a beam, in cases in which the width of the bridge is greater than half the span, has also been reviewed [20, 21]. The finite strip structural model, commonly used in static analyses of bridge decks, was adopted in the above studies. Although its accuracy remains to be established, the model considerably simplifies the modal analysis due to the transient nature of the problem.

Moving mass approximation. To account for vehicle-structure interaction, the vehicle and structure must be considered as one system. When the effect of the transverse inertia of the vehicle on the dynamical properties of the system is accounted for, the resulting boundary value problem is usually referred to as the moving mass analysis. Complex formulations in the form of partial differential equations which account for vehicles with suspensions involved in multi-vehicle traffic conditions and complex structural configurations are involved. Classic modal analysis is cumbersome for handling the kinematical coupling terms that appear in the formulation of the moving mass problem. In such a case, a combination of modal analysis and numerical integration can be used. However, this approach often requires a large number of modes for convergence; in addition, the computer code is restricted to special boundary problems.

In order to avoid solving for a system of coupled differential equations, an iterative procedure is often adopted. Mathematically, this procedure represents a weak coupling, and the convergence of the iteration is not guaranteed. Furthermore, the process can be inefficient due to the large number of modes included. Doran and Mingori [22] have shown the difficulties in their study of periodic motion vehicles on flexible guideways. A similar algorithm has been referred to by Hawk and Ghali [23] as the iterative

dynamics substructuring method. They studied a beam-slab bridge system traversed by multi-axle trucks. Cable-stayed bridges, modeled as continuous beams with elastic supports, were studied by Wilson and Barbas [24]. They also performed a number of laboratory scale model tests to validate the analysis.

In view of the complexity involved in obtaining solutions for the moving mass problem and considering the recent developments in computational facilities, it is expected that direct numerical approaches will become a primary method of analysis for practicing engineers. With the use of direct numerical approaches -- without recourse to modal expansion or iterations -- more authentic vehicle and structure models can be studied. Of greater significance is that vehicle and structure can be treated as integral parts of a single system; thus the vehicle-structure interactions can be fully accounted for. Mathematically, such an approach represents a strong coupling. In a recent study of railway-bridge impact factors, lumped parameters were used in the formulation; the vehicle was allowed to have heave, pitch, and roll motions [25].

A similar lumped parameter method was derived from the Lagrange multiplier approach [30]. Vehicle-structure interaction was treated as a kinematic constraint; hence strong coupling was included. Illustrative examples were presented to emphasize the necessity of including the coupling terms. However, because the mass, damping, and stiffness matrices are diagonal, the solution procedure requires knowledge of structural frequencies and modes. Thus, the method is somewhat restricted in its practical application in the general modeling of complex vehicle and structure characteristics.

A direct numerical algorithm, which is based on an integral formulation using structural flexibility functions, has been shown to have the capability of treating strong coupling. This method, which is referred to as the structural impedance approach, can fully account for all the kinematics of vehicle-structure interactions; it has recently been employed in solutions of more general conditions. The structural impedance approach has the advantage of being easily adaptable for computer usage. It can be conveniently applied to complex structural configurations and vehicle operating conditions.

An algorithm capable of handling multiple vehicles has been developed [26]. Each vehicle was allowed to move at variable speeds. Dynamic responses and impact factors of beams with multiple elastic supports were obtained as illustrative examples for several vehicles passing each other in the same or opposite directions. Two-dimensional cable-stayed bridge models have been incorporated into a matrix reduction method [27]. The results of the analysis compared favorably with experiments. A standard matrix analysis for trusses was incorporated into the structural impedance approach [28] to study the interaction between a traversing vehicle and a two-dimensional truss bridge. The algorithm was extended [29] to analyze the dynamic response of a continuous guideway resting on equally spaced supports traversed by a moving vehicle.

A generalized algorithm taking into account the dynamic interaction between torsional motion and the transverse motion for curved beams has been considered [31]. The solutions agreed well with the test data. A similar algorithm with an extension to bridges modeled as elastic plates [32] and to pavements with temperature-induced warping [33] has been reported. Within the same mathematical framework, the in-plane motion and out-of-plane motion of a curved pipe structure with intermediate supports conveying fluid flow with varying speed were considered [34] using the structural impedance approach.

It is of interest that this class of fluid-structure interaction problem is conceptually similar to that of a guideway subjected to a continuous vehicle mass. The kinematical coupling terms also appear in the mathematical formulation of the problem. Computer solutions [34] for the stability conditions agreed well with analytical predictions. The algorithm has subsequently been generalized to treat a three-dimensional helical pipe conveying fluid flow.

It is generally recognized that dynamic instability for highway bridges due to vehicle-structure interaction has little practical significance. However, the problem can be significant when high-speed trains are traversing a rail system; vehicle-railway interaction must be included in this coupled dynamic system. The problem is theoretically interesting and also has important practical implications in view of the rapid development and construction of high-speed trains and supertrains with magnetic levitation systems.

The railway was modeled as a continuously supported beam and a discrete model was adopted for the linear induction motor in a study of instability conditions for a fully coupled system at constant speed [35]; standard feedback control theory techniques were used. An experiment using an annular disk was reported to validate the theoretical study. A more interesting problem physically is the possibility of suppressing dynamic instability using feedback control and development of a general algorithm for more authentic vehicle and structural models [36].

EXPERIMENTAL STUDIES

Because field tests of vehicle-bridge systems are very costly and test data are difficult to interpret, data concerning the complete dynamic behavior of bridge structures are scarce. A careful calibration of vehicle system parameters is generally required as well as a complete analysis; the analysis includes the full kinematic relationships representing the vehicle-structure interactions. It is because of these interactions that measurements of bridge vibration characteristics due to moving live loads are commonly interpreted theoretically on the basis of a moving force traversing a simply supported beam. The analysis simulates a single vehicle passing a girder bridge at low speeds. Impact factors based on deflections or moments are usually the focal points in practical application; these factors ensure adequate safety margins and are used to propose proper design load factors [41].

Although it is generally recognized that a greater degree of vehicle-guideway interaction occurs for such structures as continuous span flexible bridges, monorails, and curved bridges, field measurements for the dynamic response of such structures are rare and often incomplete. Recent significant developments have been reported in this important area.

A new combined highway and railway route is presently under construction in Japan for connecting two major islands. The Honshu-Shikoku Bridge Project involves the construction of five suspension bridges with span lengths ranging from 876 m to 1780 m. To better comprehend the vehicle-structure interaction, an extensive study including model and field tests, as well as theoretical analyses, has been carried out in the last decade in a joint effort by Japan National Railways, Japan Railway Construction Corporation, and Honshu-Shikoku Bridge Authority. Summaries of the results have recently been reported [37, 38].

According to these summaries, extensive model tests were performed using a vibrating machine, shake table, and track rolling device to determine safety limits and modes of derailment and stability. Acceleration, velocity, load, and displacement inputs were provided in order to simulate track conditions. Based on experimental results a computer vehicle model with capabilities of simulating yawing, rolling, heaving, and lateral motions was developed to study moving vehicle responses. The vehicle model allows for interaction with the bridge and track deflection caused by measured and assumed wind and earthquake forces.

Vertical and in-plane deflections in railway tracks resulting from the flexible nature of the bridge structure have been a problem. Wind- and earthquake-induced bridge deflections can cause derailment or severe track misalignment. Extensive parametric studies essentially followed a moving force approach and the modal expansion technique. The effects of vehicle-structure interaction appear to be significant in predicting the dynamic response of bridge structures as vehicle velocity increases. Scaled models and full scale experiments on the Karikachi and Shikansen test tracks were performed for a wide range of speeds up to 200 km/hr.

Other significant field tests focused on the dynamic characteristics of typical highway bridges. This comprehensive experimental project was initiated in 1973 by the Indiana State Highway Commission and Purdue University as a Joint Highway Research Project [39, 40]. A total of 62 highway bridges of various types and span lengths were instrumented to record dynamic displacements and accelerations induced by the passage of various types of vehicles. Tests were conducted on ten different categories of bridge structures, including steel beam, reinforced concrete plate girder, and prestressed I-beam bridges. The number of spans varied from one to four with span lengths ranging from 27 ft to 129 ft and deck widths from 24 ft to 51 ft. Vehicle classifications ranged from single passenger cars to heavy trucks with a three axle tractor and a two axle trailer. A 21,000 lb test vehicle was also used. Test results and analyses of more than 900 vehicle crossing records have been

reported [39, 40]. Of these 900 vehicles, 65% were trucks, 30% were test vehicles, and the remaining 5% were light vehicles.

The primary objective of this comprehensive field test program is a comparative study of the dynamic responses of various bridge types subjected to normal highway traffic conditions. However, considerable information regarding the basic dynamic characteristics of bridge types has also been made available. These characteristics include displacement, velocity, acceleration and jerk histories, and the damping properties of structures.

One of the unique characteristics of this project, as compared to other field test programs, is that the test apparatus were instrumented without prior assumption of models for bridge responses. Consequently, through a frequency analysis of the measurements, bridge motion could be identified from the frequency spectra. One important finding is that the frequency spectra from all types of bridges considered show that bridge motion is composed of a combination of modes of vibration; these modes cannot be predicted by either the simple bending theory or torsion theory. From two to five distinct dominant frequencies can be present between the fundamental flexural and torsional frequencies. These modes can constitute as much as 40% of the bridge motion.

A second finding is concerned with the importance of the torsional mode of vibration. In general, the torsional modes were at least as important as the bending modes, even for vehicles traveling along the centerline of the bridge structure. In fact, in some cases the fundamental bending mode constituted only 1% of the motion; the first torsional mode contributed 25% of the motion when vehicles were traveling on the normal traffic lane. In addition, in most cases the fundamental modes were not the dominant modes.

It is expected that the results of this experimental program will be of considerable interest in the field of vehicle-structure interactions and general bridge design. The findings reported here raise significant questions concerning the accuracy of analytical studies based on the traditional modeling of bridge structures as a Bernoulli-Euler beam.

REFERENCES

1. Ting, E.C., Genin, J., and Ginsberg, J.H., "Dynamic Interaction of Bridge Structures and Vehicles," Shock Vib. Dig., 7 (11) (Nov 1975).

2. Genin, J. and Ting, E.C., "Vehicle-Guideway Interaction Problems," Shock Vib. Dig., 11 (12) (Dec 1979).

3. Hayashikawa, T. and Watanabe, N., "Dynamic Behavior of Continuous Beams with Moving Loads," ASCE J. Engrg. Mech. Div., 107 (EM1) (Feb 1981).

4. Hayashikawa, T. and Watanabe, N., "Suspension Bridge Response to Moving Loads," ASCE J. Engrg. Mech. Div., 108 (EM6) (Dec 1982).

5. Hutton, S.G. and Cheung, Y.K., "Dynamic Response of Single Span Highway Bridges," Intl. J. Earthquake Engrg. Struc. Dynam., 7 (Nov-Dec 1979).

6. Saito, H., Chonan, S., and Kawanobe, O., "Response of an Elastically Supported Plate Strip to a Moving Load," J. Sound Vib., 71 (July 1980).

7. Beltaos, S., "Field Studies on the Response of Floating Ice Sheets to Moving Loads," Can. J. Civil Engrg., 8 (1981).

8. Srinivasan, V. and Ramamurti, V., "Dynamic Response of an Annular Disk to a Moving Concentrated, In-Plane Edge Load," J. Sound Vib., 72 (Sept 1980).

9. Huang, C.-C., "Moving Loads on Viscoelastic Cylindrical Shells," J. Sound Vib., 60 (1978).

10. Chonan, S., "Response of Fluid-Filled Cylindrical Shell to a Moving Load," J. Sound Vib., 55 (Dec 1977).

11. Adams, G.G., "An Elastic Strip Moving across a Rigid Step," Intl. J. Solids Struc., 18 (2) (Sept 1982).

12. Adams, G.G., "Steady Solutions for a Moving Load on an Elastic Strip Resting on an Elastic Half Plane," Intl. J. Solids Struc., 15 (Nov 1979).

13. Yen, D.H.Y. and Gaffney, J., "On the Response of an Elastic Membrane to a Travelling Ring Load," Intl. J. Solids Struc., 13 (May 1977).

14. Suzuki, S.-I., "Dynamic Behavior of a Finite Beam Subjected to Travelling Loads with Accelerations," J. Sound Vib., 55 (Nov 1977).

15. Gupta, R.K., "Dynamic Loading of Highway Bridges," ASCE J. Engrg. Mech. Div., 106 (EM2) (Apr 1980).

16. Gupta, R.K. and Traill-Nash, R.W., "Vehicle Braking on Highway Bridges," ASCE J. Engrg. Mech. Div., 106 (EM4) (Aug 1980).

17. Gupta, R.K. and Triall-Nash, R.W., "Bridge Dynamic Loading due to Road Surface Irregularities and Braking of Vehicle," Intl. J. Earthquake Engrg. Struc. Dynam., 83 (Mar-Apr 1980).

18. Snyder, J.E. and Wormley, D.N., "Dynamic Interactions between Vehicles and Elevated, Flexible Randomly Irregular Guideways," J. Dynam. Syst., Meas. Control, Trans. ASME (Mar 1977).

19. Wiriyachai, A., Chu, K.-H., and Garg, V.K., "Bridge Impact due to Wheel and Track Irregularities," ASCE J. Engrg. Mech. Div., 108 (EM4) (Aug 1982).

20. Srinivasan, R.S. and Munaswamy, K., "Dynamic Response of Skew Bridge Decks," Intl. J. Earthquake Engrg. Struc. Dynam., 6 (Mar-Apr 1978).

21. Ramakrishnan, R. and Kunukkasseril, V.X., "Response of Circular Bridge Decks to Moving Vehicles," Intl. J. Earthquake Engrg. Struc. Dynam., 5 (Oct-Dec 1977).

22. Doran, A.L. and Mingori, D.L., "Periodic Motion of Vehicles on Flexible Guideways," J. Dynam. Syst., Meas. Control, Trans. ASME (Dec 1977).

23. Hawk, H. and Ghali, A., "Dynamic Response of Bridges to Multiple Truck Loading," Can. J. Civil Engrg., 8 (1981).

24. Wilson, J.F. and Barbas, S.T., "Responses of Continuous, Elastically Supported Beam Guideways to Transit Loads," J. Dynam. Syst., Meas. Control., Trans. ASME, 102 (Dec 1980).

25. Chu, K.-H., Garg, V.K., and Dhar, C.L., "Railway-Bridge Impact: Simplified Train and Bridge Model," ASCE J. Struc. Div., 105 (ST9) (Sept 1979).

26. Mirghaderi, R. and Ting, E.C., "Structural Impedance Method for Transient Bridge Response Subjected to General Traffic Conditions," Purdue University, School of Civil Engineering Report CE-STR-80-23 (1980).

27. Mirghaderi, R., "Dynamic Analysis of Cable-Stayed Bridges," Ph.D. Dissertation, Purdue University (Dec 1981).

28. Motabar, S., Ting, E.C., and Genin, J., "Response of Truss Bridge to Travelling Vehicle," Purdue University, School of Civil Engineering Report CE-STR-81-18 (1981).

29. Genin, J. and Chung, Y.I., "Response of a Continuous Guideway on Equally Spaced Supports Traversed by a Moving Vehicle," J. Sound Vib., 67 (2) (Nov 1979).

30. Blejwas, T.E., Feng, C.C., and Ayre, R.S., "Dynamic Interaction of Moving Vehicles and Structures," J. Sound Vib., 67 (4) (Dec 1979).

31. Genin, J., Ting, E.C., and Vafa, Z., "Curve Bridge Response to a Moving Vehicle," J. Sound Vib., 81 (4) (1982).

32. Ilkani-pour, M., Genin, J., and Ting, E.C., "Response of Plate Bridge to a Moving Mass," Purdue University, School of Civil Engineering Report CE-STR-81-30 (1981).

33. Vajarasathira, K., Yener, M., and Ting, E.C., "Dynamic Analysis of Airport Pavements," Purdue University, School of Civil Engineering Report CE-STR-82-43 (1982).

34. Lui, Y.C., "Flow-Induced Vibration of Curved Pipe Structures," Ph.D. Dissertation, Purdue University (Dec 1981).

35. Alexandridis, A.A., Dowell, E.H., and Moon, F.C., "The Coupled Response of a Dynamic

Element Riding on a Continuously Supported Beam," J. Appl. Mecn., Trans. ASME, 45 (Dec 1978).

36. Kalmbach, C.F. and Dowell, E.H., "The Suppression of a Dynamic Instability of an Elastic Body Using Feedback Control," Intl. J. Solids Struc., 10 (3) (1974).

37. Yasoshima, Y., Matsumoto, Y., and Nishioka, T., "Studies on the Running Stability of Railway Vehicles on Suspension Bridge," J. Faculty Engrg., Univ. Tokyo, 36 (1) (1981).

38. Research Committee on Runnability of Train and Honshu-Shikoku Bridge Authority, "Runnability of Train on Long-Spanned Suspension Bridge," (Mar 1978).

39. Kropp, P.K., "Experimental Study of the Dynamic response of Highway Bridges," Joint Highway Research Project Report JHRP-77-5, Purdue University (Mar 1977).

40. Gaunt, J.T. and Sutton, C.D., "Highway Bridge Vibration Studies," Joint Highway Research Project Report FHWA/IN/JHRP-81/11, Purdue University (July 1981).

41. Carr, A.J. and Moss, P.J., "Review of Impact Factors for Design of Highway Bridges," Department of Civil Engineering Report 82-14, University of Canterbury, New Zealand (May 1982).

LITERATURE REVIEW: survey and analysis of the Shock and Vibration literature

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four review articles each month, 3,000 to 4,000 words in length. The purpose of this section is to present a "digest" of literature over a period of three years. Planned by the Technical Editor, this section provides the DIGEST reader with up-to-date insights into current technology in more than 150 topic areas. Review articles include technical information from articles, reports, and unpublished proceedings. Each article also contains a minor tutorial of the technical area under discussion, a survey and evaluation of the new literature, and recommendations. Review articles are written by experts in the shock and vibration field.

This issue of the DIGEST contains an article about the vibration of overhead transmission lines.

Dr. R.N. Dubey of University of Waterloo, Waterloo, Ontario, Canada and Dr. C. Sahay of State University of New York at Binghamton, have written a review on recent literature published in various areas related to vibration of overhead transmission lines. Topics include wind loading, aeolian vibratio . wake-induced oscilla-tion, galloping, and damping.

VIBRATION OF OVERHEAD TRANSMISSION LINES IV

R.N. Dubey* and C. Sahay**

Abstract. *This review describes recent literature published in various areas related to vibration of overhead transmission lines. Topics include wind loading, aeolian vibration, wake-induced oscillation, galloping, and damping.*

Since the publication of the last review in 1980 [5] a number of theoretical and experimental papers have appeared. However, the state of the art has not yet resulted in a complete understanding of the vibration of overhead transmission lines. Different types of transmission line vibration -- aeolian and galloping as well as wave-induced vibration -- have been studied separately. A unified model has not yet been developed. However, it is heartening to note that much of the research over the past two years has been directed toward the study of wind interaction and the control of vibration through damping.

The present review is intended to encompass the literature in all areas related to vibration of overhead transmission lines. A few papers [7, 14, 17] not directly related to overhead lines are also reviewed. It is hoped that the methods employed for study and analysis in these papers will be of value in transmission line studies.

Most other reviews have discussed phenomena in parts. Fleischmann and Sallet [8, 9] described vortex shedding from cylinders in some detail. The resulting unsteady force and its relationship with vortex sheets were also discussed. The coefficients of lift and drag were formulated so as to include the effect of the Strouhal number. Experimental values of the Strouhal number for low and high ranges of the Reynolds number were plotted. They also reported the variation of the unsteady lift and drag coefficients with Reynolds number. Part II of the paper extends the discussion to non-circular and vibratory cylinders. The authors compare the results of past work with their own and suggest a general agreement of the results.

Johns [14] discussed the problem in a more general way and included more than the vibration of transmission lines. He described the nature of wind, vortex shedding, galloping, torsional vibration, flutter, divergence and buckling, turbulence, and related experiments. Migliore and Webster [17] updated cable response literature from 1979 to 1982 and included modeling of variable lengths, surface excitations, the advent of computer codes, and helpful computer packages.

Papers by Retalluck [23] and Retalluck and Bourdon [24] contain a general discussion of the behavior of conductors and bundled conductors. The significance of the papers lies in the data collected from observations at American Electric and Power and the IREQ's Magdalen Island test lines in Quebec.

WIND LOADING

Many authors have assumed the ideal and deterministic model; others [10] focused on the stochastic nature of wind loading. One model [10] is based on the simulation of wind conditions using the concept of gustiness proposed by Davenport [6]. Terrain roughness is included in the determination of design wind velocities. Statistical data for this purpose were obtained from the wind records of the Federal Aviation Administration.

Landers [15] also considered the variation of wind velocity with height and with gusts of Davenport's model; he reported EPRI efforts in the continental wind measuring program and compared wind tunnel data and apparent drag coefficient. The data suggest that, if the confidence level of the results could be proved to be high, significant reduction in design for wind loading would be possible.

*Department of Mechanical Engineering, University of Waterloo, Waterloo, Ontario, Canada
**Department of Engineering Technology, T.J. Watson School of Engineering, Applied Sciences and Technology; State University of New York at Binghamton, Binghamton, New York, U.S.A.

A numerical simulation has been attempted by Matheson and Holmes [16] for the dynamic response of transmission lines in strong wind conditions. They began with the Karman-Harris wind velocity spectrum and simulated random velocity by summing a number of complex vectors, each of which provided a correct correlation relationship with previously generated records.

AEOLIAN VIBRATION

Aeolian vibration, sometimes referred to as singing conductors, refers to relatively high frequency (10-50 Hz) vibration of transmission lines. It occurs under comparatively steady winds up to 15 miles per hour (MPH) and is due to the shedding of Karman vortices at regular intervals close to the frequency of the span. Such shedding can lead to conductor damage becuase of fatigue.

Fleishmann and Sallet [8, 9] reviewed the literature pertaining to aeolian vibration in detail. They reported the variation of Strouhal number in different ranges of Reynolds number; this variation in turn affects the unsteady lift and drag coefficients. Stationary as well as vibrating cylinders of circular and noncircular cross sections were studied.

The problem of vortex-induced vibration has been discussed with reference to cylinders and cables in liquid atmosphere [7]; the goal was to control the equipment attached to the end of the cable. The various suppression methods – boundary layer device, helical strake, shrouds – could also be of interest in overhead lines.

Hagedorn [11] took advantage of the close spacing of eigenfrequencies, approximated them by a continuous distribution, and discussed the energy balance of the system. He considered that the aerodynamic power was dissipated as mechanical energy in the damper and the material damping in the cable. The forces as well as the moments transmitted by them were built into the solution. Extensive experimental results were reported about the impedances, vibration amplitudes, and the bending strain of the cables.

Sub-span oscillation has been described [20]. The interaction of windward and leeward conductors along with the spacers separating them was discussed as were wind on and wind off conditions. It was shown that, for high wind velocities under the wind on conditions, a stable elliptical orbit of the bundle might be possible. Minimum critical speed for a twin bundle was determined and was of value in estimating the mean annual number of cycles performed by the conductor. Unequal spacing of the spacers was found to improve stability.

Ramey and Silva [21] evaluated the effects of vibration amplitude reduction on fatigue life. They also dealt with the experimental setup for simulating field data and the study thereof. Tsui [31] considered the nonlinearity of the system and combined it with the vortex shedding. He assumed the Iwan-Blevins model and estimated the amplitude of the different diameter conductors. This estimate, however, assumed a prior knowledge of the form factor.

WAKE-INDUCED OSCILLATION

Slightly different from the problem of aeolian vibration are vibration considerations of the leeward conductor because of the unsteady wake of the windward conductor in bundled conductors. This unsteady wake is referred to in technical literature as wake-induced oscillation. It usually occurs in flat terrain and during low-turbulence wind conditions (15 to 40 MPH). A frequency of oscillation up to 3 Hz can be observed.

The potential damage has been studied, and it has been shown [20] that uneven spacing of the spacers is helpful. Tsui and Tsui [30] considered the two-dimensional aerodynamic stability of two coupled conductors. They derived a set of four coupled differential equations and presented a numerical solution. The study identified the spacer coupling ratio as the single most dominant factor in determining stability. However, no experimental results for the general case of damping with a moving windward conductor were reported.

GALLOPING

Galloping is a large-amplitude vertical vibration of frequencies up to 1 Hz and can have devastating effects on transmission lines. It is characteristic of flat

terrains with freezing rain; classical flutter is believed to occur because of aerodynamic forces on ice accreted conductors. A torsional mechanism was recently suggested to explain this phenomena.

Rawlings [22] analyzed field data and performed a statistical analysis on the amplitude of vibration in order to develop an optimal design for reducing flashover. Amplitude, catenarity, wind velocity, and compliance parameters were defined. A correlation of galloping with the catenarity parameter and the acoustic velocity in the conductor was also studied. It was observed that the tendency to galloping increases as the tension to weight per unit length ratio of conductor increases. Beyond a critical value of this parameter, the maximum amplitude per span ratio again begins to decrease.

Richardson [25] reported the results of a dynamic analysis of a lightly iced cable. The drag coefficient was assumed as unity, and the moment condition was zero. The lift coefficient and the lift coefficient slope were represented by analytical approximations. Three types of dampers -- windamper, detuner pendulum, and perforated cylinder damper -- were compared. The comparisons showed that the windamper exhibited significant coupling of torsional to vertical motion. The windamper provided better galloping control than the perforated cylinders; the lattter was better than the detuner, however.

Pohlman and Landers [19] discussed the uniform and nonuniform icing of transmission lines and the way it affects vertical, transverse, longitudinal, vibrational, and aerodynamic forces. The different types of ice -- glaze, hard rime, and soft rime -- have different densities that are attributed to different icing conditions. Pohlman and Landers studied snow and icing accretion. A probabilistic mapping of icing tendencies was attempted for parts of Pennsylvania and Manitoba. The usefulness of these data is still to be shown. Ice-phobic coatings such as teflon, grease, and oils and such mechanical devices as external energy sources were also described.

Nakamura [18] developed a two-dimensional model for galloping of a two-conductor bundle assuming that ice accretion can be represented by two square prisms. He considered torsional and transverse motion and a combination of the two. Experimental results indicated that, under certain conditions, coupling of the two modes can have serious consequences.

White [32] described the effect of galloping on running angle, suspensions, deadend and heavy angle structures, and flexible cantilevered towers. The effects of galloping on running angle include destruction of insulator assemblies, cross arm, or structural components. Deadend and heavy angle structures created problems at mid-span that resulted in damage to insulators and jumpers. Flexible cantilevered towers can also be damaged by fatigue.

Rowbottom [26] attempted to identify the spans of an overhead line that are vulnerable to galloping. He used data from U.K. meteorological offices and constructed a probability density function based on orientation and wind velocity. The probabilities of clash at different stations were calculated. The model, however, needs furhter testing.

DAMPING

The study of galloping has been aimed at reducing the amplitude of vibrations. Consequently, attempts at mathematical modeling have been generally accompanied by experiments designed for those models. With respect to vibration control by aerodynamic damping both spacer and detuning pendulums were claimed to be successful in limited tests [1-4, 12, 13, 20, 22-24].

Aldham-Hughes [1] reported the use of aerodynamic dampers. Allnutt and Rowbottom [2] described the use of a mechanical damper for single as well as bundled conductors. Barnes and Vaughan [3] reported tests on damping conducted in the East Midlands. Others reported on spacer dampers utilized mostly to control aeolian vibration [4].

Simmons, Gilmore, and Dulhunty [29] began with the vibration equation of a tensioned conductor and developed a numerical scheme for handling cases in which more than one force and damper are acting in the span. They considered self damping of the conductors. It seems that the method could handle nonlinear terms to a certain extent.

Hooker and Humphreys [13] pursued the line of others [29]. They reported a test sequence with no

damper, one damper, and two dampers located at different points in the span. Frequency response was plotted, and the resonant mode shapes were figured from accelerometer measurements. The mode shapes seemed to change substantially in the vicinity of dampers. The behavior of dampers seemed to be affected by frequency and thus the line resonance.

Retalluck [23, 24] also showed the use of spring-friction, ball-socket elastomer, and estatomer pivot-type spacers and their effectiveness on the basis of measurements at Magdalen Island in Quebec. Havard [12] reported the results of a detuner pendulum used by Ontario Hydro and many U.S. power utilities and indicated a certain degree of success. Richardson [25] compared different damping devices. Others [27, 28] proposed an acceptance curve for overhead line damper evaluation based on power balance. The criterion used assures that an acceptable damper must be able to dissipate at least the difference of the wind power and structural damping provided by the cable. Use of absolute damping power means that either the fretting criteria of Rawlins or the limiting dynamic strain could be used to evaluate conductor damage. However, the relative power criterion -- damping power to the maximum power ratio -- is simpler.

CONCLUSION

The appropriateness of the stochastic approach to transmission line vibration was pointed out in the last review [5]. It is interesting to note that some research in this area has indeed been based on a probabilistic approach. The main problem is still the lack of sufficient data. However, it is hoped that as interest increases in obtaining data, more data will become available for formulating a model for study and simultaneous development and evaluation of dampers for reducing line vibration to acceptable levels.

REFERENCES

1. Aldham-Hughes, R.R., Heritage, C.A.R., Rowbottom, M.D., and Tunstall, N.J., "Field Monitoring of the Performance of CERL Aerodynamic Damper for Controlling Galloping," IEE Conf. N 176, Intl. Conf. on Progress in Cables and Overhead Lines for 220 kV and Above, p 19 (1979).

2. Allnutt, J.G. and Rowbottom, M.D., "Mechanical Dameprs for Full Span Galloping Oscillations," IEE Conf. N 176, Intl. Conf. on Progress in Cables and Overhead Lines for 220 kV and Above, p 30 (1979).

3. Barnes, J. and Vaughan, D.W., "Report on Subconductor Oscillation and Galloping Conductor in East Midlands," IEE Conf. N 176, Intl. Conf. on Progress in Cables and Overhead Lines for 220 kV and Above, p 47 (1979).

4. Champa, R.J., Poffenberger, J.C., and Siter, R.B., "Testing of a New Spacer Damper," IEE Conf. N 176, Intl. Conf. on Progress in Cables and Overhead Lines for 220 kV and Above, p 35 (1979).

5. Dubey, R.N. and Sahay, C., "Vibration of Overhead Transmission Lines - III," Shock Vib. Dig., 12 (12), p 11 (1980).

6. Davenport, A.G., "Gust Response Factors for Transmission Line Loading," Wind Engrg. Proc., Intl. Conf., 5th, 2, p 899 (1980).

7. Every, M.J., King, R., and Weaver, D.S., "Vortex Excited Vibrations of Cylinders and Cables and Their Suppression," Ocean Engrg., 9 (2), p 135 (1982).

8. Fleischmann, S.T. and Sallet, D.W., "Vortex Shedding from Cylinders and the Resulting Unsteady Forces and Flow Phenomena - Part I," Shock Vib. Dig., 13 (11), p 13 (1981).

9. Fleischmann, S.T. and Sallet, D.W., "Vortex Shedding from Cylinders and the Resulting Unsteady Forces and Flow Phenomena - Part II," Shock Vib. Dig., 13 (12), p 13 (1981).

10. Goodwin, E.J., Davenport, A.G., Davison, H.L., Diogioa, A.M., and Power, B.A., "Probability Based Wind Loadings for the Design of Transmission Line Structures," IEEE Trans. Power Appar. Syst., PAS-100 (6), p 2705 (1981).

11. Hagedorn, P., "On the Computation of Damped Wind-Excited Vibration of Overhead Transmission Lines," J. Sound Vib., 83 (2), p 253 (1982).

12. Havard, D.G., Nigol, O., and Pohlman, J.C., "Progress in Control of Conductor by Detuning," IEEE Conf. N 176, Intl. Conf. on Progress in Cables and Overhead Lines for 220 kV and Above, p 13 (1979).

13. Hooker, R.J. and Humphreys, W., "Damping of Electrical Tranmission Lines Part II - Field and Laboratory Studies," IEE Conf. N 176, Intl. Conf. on Progress in Cables and Overhead Lines for 220 kV and Above, p 57 (1979).

14. Johns, D.J., "Wind Excited Behavior of Structures - III," Shock Vib. Dig., 14 (7), p 23 (1982).

15. Landers, P.G., "EPRI Sponsored Transmission Line Wind Loading Research," IEEE Trans. Power Appar. Syst., PAS-101 (8), p 2460 (1982).

16. Matheson, M.J. and Holmes, J.D., "Simulation of the Dynamic Response of Transmission Lines in Strong Winds," Engrg. Struc., 3 (2), p 105 (1981).

17. Migliore, H. and Webster, L., "Current Methods for Analyzing Dynamic Cable Response 1979 to the Present," Shock Vib. Dig., 14 (9), p 19 (1982).

18. Nakamura, Y., "Galloping of Bundled Power Line Conductors," J. Sound Vib., 73 (3), p 363 (1980).

19. Pohlman, J.C. and Landers, P., "Present State of Art of Transmission Line Icing," IEEE Trans. Power Appar. Syst., PAS-010 (8), p 2443 (1982).

20. Price, S.J., Allnutt, J.G., and Tunstall, M.J., "Sub-Span Oscillation of Bundled Conductors," IEE Conf. N 176, Intl. Conf. in Cables and Overhead Lines for 220 kV and Above, p 41 (1979).

21. Ramey, G.E. and Silva, J.M., "An Experimental Evaluation of Conductor Aeolian Fatigue Damage Mitigation by Amplitude Reduction," IEEE Trans. Power Appar. Syst., PAS-100 (12), p 4935 (1981).

22. Rawlins, C.B., "Analysis of Conductor Galloping Field Observations - Single Conductors," IEEE Trans. Power Appar. Syst., PAS-100 (8), p 3744 (1981).

23. Retailuck, R.L., "Performance of Multi Conductor Bundles on EHV and UHV Lines under Wind," Proc. Amer. Power Conf., 42, p 455 (1980).

24. Retalluck, R.L. and Bourdon, P., "American Electric Power-UHV Bundle Conductor Tests at Magdalen Islands," IEEE Trans. Power Appar. Syst., PAS-100 (12), p 4926 (1981).

25. Richardson, A.S., "Dynamic Analysis of Lightly Iced Conductor Galloping in Two Degrees of Freedom," IEE Proc., 128 C (6), p 211 (1981).

26. Rowbottom, M.D., "Methods of Calculating the Vulnerability of an Overhead Transmission Line to Faults Caused by Galloping," IEE Proc., 128 C (6), p 334 (1981).

27. Sathikh, S. and Chari, R.T., "Acceptance Curve - A Practical Means of EHV Transmission Line Damper Performance Evaluation," Elec. Power Syst. Res., 4, p 67 (1981).

28. Sathikh, S., Rammurti, V., and Chari, R.T., "Acceptance Curve for Overhead Line Damper Evaluation," Proc. IEEE, 68 (5), p 634 (1980).

29. Simmons, J.M., Gilmore, K.L., and Dulhunty, P.W., "Damping of Electrical Transmission Lines; Part I: Analysis and Numerical Simulation," IEE Conf. N 176, Intl. Conf. on Progress in Cables and Overhead Lines for 220 kV and Above, p 51 (1979).

30. Tsui, Y.T. and Tsui, C.C., "On Wave Induced Flutter of a Circular Conductor in the Wake of Another," J. Pressure Vessel Tech., Trans. ASME, 102, p 125 (1980).

31. Tsui, Y.T., "Recent Advances in Engineering Science as Applied to Aeolian Vibration. An Alternative Approach," Elec. Power Syst. Res., 5, p 73 (1982).

32. White, H. Brian, "Some Destructive Mechanisms Activated by Galloping Conductors," Paper No. A 79 106-6, IEEE PES Winter Mtg. (1979).

BOOK REVIEWS

THE MATHEMATICAL THEORY OF WAVE MOTION

G.R. Baldock and T. Bridgeman
Halsted Press, Div. of John Wiley & Sons,
New York, NY, 1981, 261 pp, $64.95

The book presents a unified mathematical treatment of the phenomenon of wave motion at an introductory level. It is aimed at introducing undergraduate students in physics, mathematics, and engineering to the subject of wave propagation. The authors have succeeded in bringing out the mathematics used to solve wave propagation problems that arise in acoustics and electromagnetics. They also treat the problem of water waves.

The book has 12 main chapters and an Appendix (Chapter 13). Chapter 1 deals with a description of one-dimensional wave equations and wave motions in various physical systems. Chapters 2-4 are devoted to various methods of solving the initial and boundary problems of one-dimensional wave motion. A concise treatment of dispersion is given in Chapter 5. Dispersion is also discussed in Chapter 6 in the context of a discrete system and in Chapter 10, where water waves are treated. Chapter 7-9 deal with waves in two and three dimensions. In Chapters 10 and 11 a concise treatment of the theory of hyperbolic equations and the solutions of the Cauchy problem are given. Each chapter has exercise problems. The Appendix is devoted to a short discussion of some special functions (Gamma, Bessel, and Legendre). The book should be very useful for a one semester introductory course on wave propagation in American universities.

S.K. Datta
Department of Mechanical Engineering
University of Colorado
Boulder, CO 80306

DYNAMIC RESPONSE OF STRUCTURES TO WIND AND EARTHQUAKE LOADING

P.L. Gould and S.H. Abu-Sitta
Halsted Press, Div. of John Wiley & Sons
New York, NY, 1980, 175 pp

The authors state that the book is intended to provide appropriate background and to introduce methods of analysis for structures under dynamic loading. The book is directed toward the practicing engineer or advanced student with a general background in structural mechanics. According to the authors an integrated treatment of structural response to two important types of natural loadings, wind and earthquake, seems to be warranted because of a number of commonalities.

The book contains eight chapters. Chapter 1 treats the structural dynamics of single-degree-of-freedom systems and contains a short section on elasto-plastic and base disturbance models. Chapter 2 has to do with random processes: statistical parameters, probability, auto-correlation,and combined random processes (cross spectral density and cross correlation). Gaussian distribution is mentioned, but Rayleigh distribution is omitted.

Chapter 4 considers structural dynamics of many-degrees-of-freedom systems: equations of motion, orthogonality, generalized coordinates, undamped free vibration, and base disturbance. The chapter concludes with generalizations applied to continuous systems.

Chapter 5 has to do with random loading and multi-degree-of-freedom systems. The authors apply cross spectral and cross correlation to a structure. Joint acceptance, rarely seen in vibration texts, is explained in terms of the cross correlation and applied to slender flexible plane and axisymmetric structures. The reviewer feels that applications to beams and plates should have been included.

Chapter 6 deals with wind effects on structures including nature of wind and wind loading plus atmospheric turbulence. The response of rectangular structures -- effects due to pressure spectra, gust factors, and pressure coefficients - are described.

Both authors have published a number of papers on response of tapered chimneys, cylindrical towers, and response of suspended roofs. They incorporate the most important sections of these papers in the book. All are discussed in terms of geometrical loading characteristics, fluctuating pressure distribution, and dynamic pressure. The concluding section of Chapter 6 is concerned with vortex shedding, galloping, and flutter.

Chapter 7 focuses upon earthquake effects of structures. The authors consider classification systems and elastic wave models of earthquakes. Response spectra unique to earthquake design, design spectra, inelastic spectra, and seismic analysis of a hyperbolic cooling tower are given. Time domain analysis, including direct integration of equations of motion and response of secondary systems is described. The reviewer feels that Newmark β method and Wilson θ method of integration of the basic equation of motion should have been included. The final section of this chapter considers series representation via transfer functions, soil-structure systems, and non-determinate analysis. This chapter is informative, but additional discussion on response spectra would have been welcome. Chapter 8 is an interesting discourse on treatment of wind and earthquake loading on structures.

The authors have attempted to cover too much ground in too few pages. A table of symbols should have been included. Derivations used in modal analysis and computer programs in which theory is applied to practice would be a tremendous asset. The reviewer suggests that future additions of the book should be expanded and less reliance placed upon references.

H. Saunders
General Electric Company
Building 41, Room 307
Schenectady, NY 12345

ENGINEERING ACOUSTICS AND NOISE CONTROL

C.J. Hemond, Jr.
Prentice-Hall, Inc., Englewood Cliffs, NJ
1983, 129 pp

This short book, intended as an undergraduate text at the senior level, contains 12 chapters in two parts. The title misrepresents the contents because the book is neither well thought-out nor sufficiently detailed to be an adequate text or reference source on engineering acoustics and noise control.

First some general comments. On the positive side, the book is neat, easy to read, and assumes the readers are both men and women. On the negative side, however, the book is virtually void of references, of citations from which the author obtained his materials, and of discussion of any standards (measurement or instruments). It tends to be repetitive. Few example problems are given, and no answers are given for the problems following each chapter. The editing is careless: symbols have been inserted improperly, upper and lower case symbols have been interchanged, and figures are poorly labeled.

Now I shall elaborate some of the problems I found with the book, chapter by chapter, in order to give the reader some understanding as to how I judged this work. The first chapter is titled "Terminology." Octave bands and third octave bands are discussed without benefit of either a diagram showing a filter shape, a discussion of filters in general, or mention of applicable ANSI standards. As a result, a student will believe Hemond's statement that ". . . each band covers a range of frequencies and excludes all others" (underlining is mine). The definition of "c", a scalar in most equations, is speed of sound, not velocity as stated by the author. Because the book is about engineering acoustics, the author should derive, not merely state, the equation relating characteristic impedance in terms of density and speed of sound, and he should explain why the ratio of pressure to particle velocity is a complex term. His use of the word intensity for power can only confuse the student. Lack of definition for uncorrelated sound sources and no equations to combine two or more of them (the author provides a table) are two additional omissions of essential information in a book of this type.

The second chapter deals with reflection, reverberation, and refraction and includes sections that should have been placed in the architectural section of the book. The chapter contains little in the way of engineering derivations and assumptions; for example, it would have been useful if the author had discussed reverberation time as a function of frequency.

The third chapter on diffraction and interference presents a complex equation for barriers. The lack of derivations or assumptions used and vague explanations make the section not especially useful. The discussion of in holes barriers introduces the term transmission loss potential, but the author provides no explanations.

In the chapter about sound absorption Hemond states " . . . it is well to note that some manufacturers list acoustically absorbing materials of over 1.00 (that is, better than 100 percent absorbent). This is, of course, a gimmick to take advantage of the lack of basic knowledge of the concept of absorption." Anyone familiar wit ASTM C-423-81a would know that values greater than one are due to diffraction effects not yet completely understood. The standard recommends reporting calculated absorption coefficients with no adjustment for diffraction. The section on flow resistance and impedance tubes contains no mathematical or heuristic developments of the equations presented. The section on optimal reverberation times contains no information about acceptability ranges. In an attempt to present absorption coefficients of common materials the author cites an untitled, annual publication of NBS that is obscure at best.

The major derivation in the book appears in the chapter on transmission loss. This chapter is flawed, however, by Hemond's explanation of critical frequency as "the natural frequency of resonance of that material." The source cited for Sound Transmission Class is the Standards Committee of ASTM. It would take significant research to find this committee and the definition of STC using the source. (The committee is E-33 on Environmental Acoustics.) The author notes that field tests can be performed with broad band noise but that "a series of frequencies from 125Hz to 4KHz should be used." I am not aware of any test methods using this pure tone technique. I suspect the author did not mean the pure tone technique, but the implication is there.

Finally, in this chapter I am surprised that Hemond did not include a chart showing the effects of composite TL -- it would have been a practical discussion for the student.

The chapter on hearing contains a one-page treatment of Federal Standards (OHSA and the "US Department of Health"). Considering the impetus for noise control the discussion is too brief. The chapter on loudness refers to noise exposure forecasts and composite noise rating, two metrics that have not been popular for years, and a quarter page treatment each of Leq and Ldn. Surely both latter metrics deserve a reasonably lengthy discussion.

At best, the part of the book that deals with noise control is benign. The chapter on systematic approaches to noise control contains no practical or detailed examples. Hemond generalizes: "we can always move the receiver away from the source." In my opinion this is just not the case. The section on sound level meters in the chapter on instrumentation omits even the types defined in ANSI S1.4 and assumes the reader knows what a rectifier does. Again no mention is made of classes of filters for sound level meters.

The author states that the time base of a graphic level recorder is set by both paper and writing speeds. In those recorders with which I am familiar, time base does not depend on writing speed. Hemond says an FFT will work in "real time." This obfuscates an important difference between an FFT and real time analyzer. The chapter on community noise is fair, as is the one on air distribution noise. The last chapter on architectural acoustics briefly treats several areas (masking, reverberation, modeling) but is too short to be useful.

So, what do I recommend? For college work, Irwin and Graf's Industrial Noise Control; for architectural acoustics, Dave Egan's Concepts in Architectural Acoustics or ASA's reprint of Harris and Crede's Architectural Acoustics. Practical aspects of noise control can be found in many texts including a book by L. Bell, Industrial Noise Control, Harris' Handbook of Noise Control, and Yerges' Sound, Noise and Vibration Control.

R.J. Peppin
P.O. Box 8365
Rockville, MD 20856

SHORT COURSES

JANUARY

LECTURE/TRAINING COURSE ON NAVAL SHOCK

Dates: January 9-13, 1984
Place: San Diego, CA

Objective: Combat survivability is a key issue in the design of naval ships. Current DoD policy highlights survivability as an essential requirement in the ship acquisition process. The wars in South East Asia, the Middle East and, recently, in the Falkland Island conflict accentuated the need for combat survivability. Since shock induced by various weapons is a major and highly destructive weapon effect, design for survival under shock is a vital part of the ship survivability process. Hence, under present Navy policy, all mission-essential equipment must qualify to rigorous shock hardening requirements. Naval Systems Commands and Laboratories, shipbuilders and equipment suppliers all play a role in the shock hardening process. If you work for the Navy, you may be involved in the implementation and verification of the Navy shock requirements, or you may be responsible for the purchase of electronic or weapon systems that must be shock qualified. As an employee of a major shipbuilder or a Naval equipment supplier, you may be faced with broad and/or specific aspects of Naval shock design. This lecture/training course has been developed to help engineers, scientists, Naval architects and others understand and effectively deal with the U.S. Navy's ship shock hardening requirements. If you are faced with ship shock problems, participation in this course should increase your value to your organization and enhance your own career advancement.

Contact: Henry C. Pusey or Maurisa Gohde, NKF Engineering Associates, Inc., 8150 Leesburg Pike, Suite 700, Vienna, VA 22180 - (703) 442-8900.

MACHINERY VIBRATION ENGINEERING

Dates: January 24-27, 1984
Place: Houston, TX
Dates: July 17-20, 1984
Place: Oak Brook, Illinois
Dates: November 27-30, 1984
Place: Washington, D.C.

Objective: Techniques for the solution of machinery vibration problems will be discussed. These techniques are based on the knowledge of the dynamics of machinery; vibration measurement, computation, and analysis; and machinery characteristics. The techniques will be illustrated with case histories involving field and design problems. Familiarity with the methods will be gained by participants in the workshops. The course will include lectures on natural frequency, resonance, and critical speed determination for rotating and reciprocating equipment using test and computational techniques; equipment evaluation techniques including test equipment; vibration analysis of general equipment including bearings and gears using the time and frequency domains; vibratory forces in rotating and reciprocating equipment; torsional vibration measurement, analysis, and computation on systems involving engines, compressors, pumps, and motors; basic rotor dynamics including fluid film bearing characteristics, critical speeds, instabilities, and mass imbalance response; and vibration control including isolation and damping of equipment installation.

Contact: The Vibration Institute, 101 West 55th Street, Clarendon Hills, IL 60514 - (312) 654-2254.

RELIABILITY METHODS IN MECHANICAL AND STRUCTURAL DESIGN

Dates: January 30 - February 3, 1984
Place: Tucson, Arizona

Objective: The objective of this short course and workshop is to review the elements of probability and statistics and the recent theoretical and practical developments in the application of probability theory and statistics to engineering design. Special

emphasis will be given to fatigue and fracture reliability.

Contact: Special Professional Education, Harvill Building No. 76, Room 237, College of Engineering, The University of Arizona, Tucson, AZ 85721 - (602) 621-3054.

FEBRUARY

VIBRATION AND SHOCK SURVIVABILITY, TESTING, MEASUREMENT, ANALYSIS, AND CALIBRATION

Dates: February 6-10, 1984
Place: Santa Barbara, California
Dates: March 5-9, 1984
Place: Washington, DC
Objective: Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis; also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and techniques, rather than upon mathematics and theory.

Contact: Wayne Tustin, 22 East Los Olivos Street, Santa Barbara, CA 93105 - (805) 682-7171.

MACHINERY VIBRATION ANALYSIS

Dates: February 21-24, 1984
Place: San Francisco, California
Dates: May 15-18, 1984
Place: Nashville, Tennessee
Dates: August 14-17, 1984
Place: New Orleans, Louisiana
Objective: In this four-day course on practical machinery vibration analysis, savings in production losses and equipment costs through vibration analysis and correction will be stressed. Techniques will be reviewed along with examples and case histories to illustrate their use. Demonstrations of measurement and analysis equipment will be conducted during the course. The course will include lectures on test equipment selection and use, vibration measurement and analysis including the latest information on spectral analysis, balancing, alignment, isolation, and damping. Plant predictive maintenance programs, monitoring equipment and programs, and equipment evaluation are topics included. Specific components and equipment covered in the lectures include gears, bearings (fluid film and antifriction), shafts, couplings, motors, turbines, engines, pumps, compressors, fluid drives, gearboxes, and slow-speed paper rolls.

Contact: The Vibration Institute, 101 West 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

DYNAMIC BALANCING SEMINAR/WORKSHOP

Dates: February 22-23, 1984
March 21-22, 1984
April 18-19, 1984
May 23-24, 1984
Place: Columbus, Ohio
Objective: Balancing experts will contribute a series of lectures on field balancing and balancing machines. Subjects include: field balancing methods; single, two and multi-plane balancing techniques; balancing tolerances and correction methods. The latest in-place balancing techniques will be demonstrated and used in the workshops. Balancing machines equipped with microprocessor instrumentation will also be demonstrated in the workshop sessions, where each student will be involved in hands-on problem-solving using actual armatures, pump impellers, turbine wheels, etc., with emphasis on reducing costs and improving quality in balancing operations.

Contact: R.E. Ellis, IRD Mechanalysis, Inc., 6150 Huntley Rd., Columbus, OH 43229 - (614) 885-5376.

MARCH

MEASUREMENT SYSTEMS ENGINEERING

Dates: March 12-16, 1984
Place: Phoenix, Arizona

MEASUREMENT SYSTEMS DYNAMICS

Dates: March 19-23, 1984
Place: Phoenix, Arizona
Objective: Program emphasis is on how to increase productivity and cost-effectiveness for data acquisition groups in the field and in the laboratory. The program is intended for engineers, scientists and managers of industrial, governmental and educational organizations who are concerned with planning,

executing, or interpreting experimental data and measurements. The emphasis is on electrical measurements of mechanical and thermal quantities.

Contact: Peter K. Stein, Director, Stein Engineering Services, Inc., 5602 East Monte Rosa, Phoenix, AZ 85018 - (602) 945-4603/946-7333.

APRIL

MODAL TESTING

Dates: April 3-6, 1984
Place: San Diego, California
Dates: August 14-17, 1984
Place: New Orleans, Louisiana
Objective: Vibration testing and analysis associated with machines and structures will be discussed in detail. Practical examples will be given to illustrate important concepts. Theory and test philosophy of modal techniques, methods for mobility measurements, methods for analyzing mobility data, mathematical modeling from mobility data, and applications of modal test results will be presented.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

ROTOR DYNAMICS

Dates: April 30 - May 4, 1984
Place: Syria, Virginia
Objective: The role of rotor/bearing technology in the design, development and diagnostics of industrial machinery will be elaborated. The fundamentals of rotor dynamics; fluid-film bearings; and measurement, analytical, and computational techniques will be presented. The computation and measurement of critical speeds vibration response, and stability of rotor/bearing systems will be discussed in detail. Finite elements and transfer matrix modeling will be related to computation on mainframe computers, minicomputers, and microprocessors. Modeling and computation of transient rotor behavior and nonlinear fluid-film bearing behavior will be described. Sessions will be devoted to flexible rotor balancing including turbogenerator rotors, bow behavior, squeeze-film dampers for turbomachinery, advanced concepts in troubleshooting and instrumentation, and case histories involving the power and petrochemical industries.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th Street, Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254.

NEWS BRIEFS: news on current and Future Shock and Vibration activities and events

Call for Papers

INTER-NOISE 84
December 3-5, 1984
Honolulu, Hawaii

INTER-NOISE 84, the 13th International Conference on Noise Control Engineering, will be held at the Hotel Ilikai in Honolulu, Hawaii on December 3-5, 1984. With the theme "International Cooperation for Noise Control," the conference will be sponsored by the International Institute of Noise Control Engineering (I/INCE) and organized by INCE/USA in cooperation with the INCE/Japan. This will be the first time that two member societies of International INCE have cooperated in the organization of an INTER-NOISE conference, which will include technical sessions consisting of invited and contributed presentations on worldwide noise-control technology as well as poster sessions and an exhibition of the latest equipment and instrumentation for noise control. A series of distinguished lectures will be presented by recognized specialists. The emphasis during INTER-NOISE 84 will be on practical solutions to important noise control problems.

Contributions in all areas of noise control engineering for the technical program are welcome. Of particular interest are the following topics:

- machinery noise reduction at the source
- reduction of in-plant noise exposures
- noise control in specific industries
- noise control for vehicles and transportation systems
- community noise, including construction, aircraft, etc.
- planning for industrial and community noise control
- engine noise control
- shipboard noise control
- source identification and diagnostics
- noise control elements: barriers, enclosures, mufflers, etc.
- noise standards, regulations and labeling
- noise control engineering in buildings
- noise control for household appliances
- noise measurements, analysis and instrumentation
- engineering curricula for noise control eduction
- active noise attenuators

The deadline date for the receipt of abstracts is March 15, 1984. Authors will be notified by May 15, 1984 of the acceptance of their abstracts. The firm deadline for the receipt of complete manuscripts is July 15, 1984.

For further information contact: William W. Lang, Chairman, INTER-NOISE 84, P.O. Box 3469 Arlington Branch, Poughkeepsie, NY 12603.

ABSTRACT CATEGORIES

MECHANICAL SYSTEMS

Rotating Machines
Reciprocating Machines
Power Transmission Systems
Metal Working and Forming
Isolation and Absorption
Electromechanical Systems
Optical Systems
Materials Handling Equipment

STRUCTURAL SYSTEMS

Bridges
Buildings
Towers
Foundations
Underground Structures
Harbors and Dams
Roads and Tracks
Construction Equipment
Pressure Vessels
Power Plants
Off-shore Structures

VEHICLE SYSTEMS

Ground Vehicles
Ships
Aircraft
Missiles and Spacecraft

BIOLOGICAL SYSTEMS

Human
Animal

MECHANICAL COMPONENTS

Absorbers and Isolators
Springs
Tires and Wheels
Blades
Bearings
Belts
Gears
Clutches
Couplings
Fasteners
Linkages
Valves
Seals
Cams

STRUCTURAL COMPONENTS

Strings and Ropes
Cables
Bars and Rods
Beams
Cylinders
Columns
Frames and Arches
Membranes, Films, and Webs
Panels
Plates
Shells
Rings
Pipes and Tubes
Ducts
Building Components

ELECTRIC COMPONENTS

Controls (Switches, Circuit Breakers)
Motors
Generators
Transformers
Relays
Electronic Components

DYNAMIC ENVIRONMENT

Acoustic Excitation
Shock Excitation
Vibration Excitation
Thermal Excitation

MECHANICAL PROPERTIES

Damping
Fatigue
Elasticity and Plasticity
Wave Propagation

EXPERIMENTATION

Measurement and Analysis
Dynamic Tests
Scaling and Modeling
Diagnostics
Balancing
Monitoring

ANALYSIS AND DESIGN

Analogs and Analog Computation
Analytical Methods
Modeling Techniques
Nonlinear Analysis
Numerical Methods
Statistical Methods
Parameter Identification
Mobility/Impedance Methods
Optimization Techniques
Design Techniques
Computer Programs

GENERAL TOPICS

Conference Proceedings
Tutorials and Reviews
Criteria, Standards, and Specifications
Bibliographies
Useful Applications

ABSTRACTS FROM THE CURRENT LITERATURE

Copies of publications abstracted are not available from SVIC or the Vibration Institute, except those generated by either organization. Government Reports (AD-, PB-, or N-numbers) can be obtained from NTIS, Springfield, Virginia 22151; Dissertations (DA-) from University Microfilms, 313 N. Fir St., Ann Arbor, Michigan 48106; U.S. Patents from the Commissioner of Patents, Washington, DC 20231; Chinese publications (CSTA-) in Chinese or English translation from International Information Service Ltd., P.O. Box 24683, ABD Post Office, Hong Kong. In all cases the appropriate code number should be cited. All other inquiries should be directed to libraries. The address of only the first author is listed in the citation. The list of periodicals scanned is published in issues 1, 6, and 12.

ABSTRACT CONTENTS

MECHANICAL SYSTEMS

ROTATING MACHINES

(Also see Nos. 2430, 2495, 2508, 2534, 2546, 2566, 2567)

83-2355

Development of Methodology for Horizontal Axis Wind Turbine Dynamic Analysis

J. Dugundji

Massachusetts Inst. of Tech , Cambridge, MA, Rept. No. NASA-CR-168110, 11 pp (Sept 1982)

N83-22747

Key Words: Wind turbines, Computer programs

Horizontal axis wind turbine dynamics are studied. The following findings are summarized: review of the MOSTAS computer programs for dynamic analysis of horizontal axis wind turbines; review of various analysis methods for rotating systems with periodic coefficients; review of structural dynamics analysis tools for large wind turbines; experiments for yaw characteristics of a rotating rotor; development of a finite element model for rotors; development of simple models for aeroelastics; and development of simple models for stability and response of wind turbines on flexible towers.

83-2356

Dynamics Analysis of Emergency Overspeed Governor for Turbomachines

Kuo Shu Fen

JCME, 18 (4), pp 43-51 (1982)

CSTA 621.8-82.94

Key Words; Turbomachinery, Safety devices

The emergency overspeed governor is the most important protection device for reliable operation of high speed turbomachines and also a major safety item on large modern steam turbines. There are two types of construction -- ring type and bolt type. The dynamics characteristics, relation of construction factors, and derived calculation formulae are described. The accuracy of the theoretical analysis is verified by experiments.

83-2357

An Improved Method for Calculating Critical Speeds and Rotordynamic Stability of Turbomachinery

B.T. Murphy and J.M. Vance

Mech. Engrg., Texas A&M Univ., College Station, TX, J. Engrg. Power, Trans. ASME, 105 (3), pp 591-595 (July 1983) 7 figs, 13 refs

Key Words: Turbomachinery, Critical speeds, Transfer matrix method, Computer programs

It is shown that by rearranging the calculations performed in a transfer matrix program, one can derive the characteristic polynomial for a complex rotor-bearing system with no loss in generality. The modeling procedures are identical for the rotor and bearing/foundations, including the effects of gyroscopics, damping, and any or all destabilizing influences which are linearized in the usual manner. With the characteristic polynomial known, critical speeds can be estimated and stability predicted with greater efficiency and with no fear of missing any modes. Such a program has been written, and a complete comparison between two types of programs is shown.

83-2358

A Contribution to the Investigation of Compressor System Behavior During Surge (Zur Berechnung des instationären Verhaltens von Verdichteran'..gen während des Pumpens)

J. Wachter and K. H. Rohne

Universitat Stuttgart, Institut f. Thermische Strömungsmaschinen und Maschinenlaboratorium, Forsch. Ingenieurwesen, 49 (4), pp 107-111 (1983) 10 figs, 15 refs

(In German)

Key Words: Compressors, Fluid-induced excitation

The surge-behavior of a three stage centrifugal compressor is investigated. Experimental data are compared with theoretical results from two different mathematical models. In both cases satisfactory agreement is achieved.

83-2359

Aerodynamic Damping Measurements in a Transonic Compressor

E.F. Crawley

Dept. of Aeronautics and Astronautics, Massachusetts

Inst. of Tech., Cambridge, MA 02139, J. Engrg. Power, Trans. ASME, 105 (3), pp 575-584 (July 1983) 14 figs, 17 refs

Key Words: Compressors, Aerodynamic damping

A method has been developed and demonstrated for the direct measurement of aerodynamic damping in a transonic compressor. The method is based on the inverse solution of the structural dynamic equations of motion of the blade-disk system. The equations are solved inversely to determine the forces acting on the system. If the structural dynamic equations are transformed to multiblade or modal coordinates, the damping can be measured for blade-disk modes, and related to a reduced frequency and interblade phase angle. This method of damping determination was demonstrated using a specially instrumented version of the MIT transonic compressor.

83-2360

Transient Vibration of High-Speed, Lightweight Rotors Due to Sudden Imbalance

M. Sakata, T. Aiba, and H. Ohnabe

Dept. of Physical Engrg., Tokyo Inst. of Tech., Ookayama, Meguro-ku, Tokyo, Japan, J. Engrg. Power, Trans. ASME, 105 (3), pp 480-486 (July 1983) 12 figs, 11 refs

Key Words: Rotors, Transient response, Unbalanced mass response, Blade loss dynamics

A transient vibration analysis is carried out on a flexible-disk/flexible-shaft system or rigid-disk/flexible-shaft system subjected to a sudden imbalance that is assumed to represent the effect of blade loss. To solve the basic equation governing a rotating flexible disk the Galerkin's method is used, and the equation of motion of the rotor system is numerically solved by employing the Runge-Kutta-Gill's method. Experiments are conducted on a model rotor having a blade loss simulator; the shaft vibrations are also measured. The validity of the analytical results is demonstrated by comparison with experimental results.

83-2361

Investigations of Hingeless Rotor Stability

R.A. Ormiston

Rotorcraft Dynamics Div., Aeromechanics Lab., U.S. Army Res. & Tech. Labs. (AVRADCOM), Moffett Field, CA 94035, Vertica, 7 (2), pp 143-181 (1983) 43 figs, 2 tables, 42 refs

Key Words: Rotors, Hingeless rotors, Helicopters, Dynamic stability

An overview of the technical development of hingeless and bearingless rotors is given, with emphasis on aeroelastic and aeromechanical stability characteristics. Important considerations for theoretical analysis are discussed. Theoretical and experimental investigations of isolated blade flap-lag and flap-lag-torsion stability, and coupled rotor-body aeromechanical stability are described. Physical interpretation and important rotor system design parameters are emphasized. An overview of bearingless rotor dynamics is also included.

83-2362

Experimental Evaluation of Squeeze Film Supported Flexible Rotors

M.D. Rabinowitz and E.J. Hahn

Hawker De Havilland Australia, Lidcombe, New South Wales, Australia, J. Engrg. Power, Trans. ASME, 105 (3), pp 495-503 (July 1983) 18 figs, 15 refs

Key Words: Rotors, Flexible rotors, Squeeze film bearings, Experimental test data

This paper describes the experimental investigations which were conducted to verify existing theoretical vibration amplitude predictions for centrally preloaded, squeeze film supported flexible rotors. The influence of measurement errors and operating condition uncertainties are quantified. The agreement between theory and experiment was excellent, and it is shown that any discrepancy can be explained in terms of errors in determining the mean lubricant viscosity and the orbit magnitudes.

83-2363

Nonlinear Analysis of Rotor-Bearing Systems Using Component Mode Synthesis

H.D. Nelson, W.L. Meacham, D.P. Fleming, and A.F. Kascak

Lewis Res. Ctr., Cleveland, OH 44135, J. Engrg. Power, Trans. ASME, 105 (3), pp 606-614 (July 1983) 8 figs, 7 tables, 19 refs

Key Words: Rotors, Nonlinear theories, Component mode synthesis, Blade loss dynamics, Unbalanced mass response, Computer programs

The method of component mode synthesis is developed to determine the forced response of nonlinear, multishaft, rotor-bearing systems. The formulation allows for simulation of system response due to blade loss, distributed unbalance, base shock, maneuver loads, and specified fixed frame forces. The motion of each rotating component of the system is described by superposing constraint modes associated with boundary coordinates and constrained precessional modes associated with internal coordinates. The precessional modes are truncated for each component and the reduced component equations are assembled with the nonlinear supports and interconnections to form a set of nonlinear system equations of reduced order. These equations are then numerically integrated to obtain the system response. A computer program, which is presently restricted to single shaft systems, has been written and results are presented for transient system response associated with blade loss dynamics, squeeze film dampers, and interference rubs.

83-2364

In-Plane Inertial Coupling in Tuned and Severely Mistuned Bladed Disks

E.F. Crawley

Dept. of Aeronautics and Astronautics, Massachusetts Inst. of Tech., Cambridge, MA 02139, J. Engrg. Power, Trans. ASME, 105 (3), pp 585-590 (July 1983) 5 figs, 8 refs

Key Words: Rotors, Blades, Disks (shapes), Shafts, Coupled response

A model is developed and verified for blade-disk-shaft coupling in rotors due to the in-plane rigid body modes of the disk. An analytic model is derived which couples the in-plane rigid body modes of the disk on an elastic shaft with the blade bending modes. Bench resonance tests are carried out on the MIT compressor rotor, typical of research rotors with flexible blades and a thick rigid disk.

83-2365

Closed-Form, Steady-State Solution for the Unbalance Response of a Rigid Rotor in Squeeze Film Damper

D.L. Taylor and B.R.K. Kumar

Sibley School of Mech. and Aerospace Engrg., Cornell Univ., Ithaca, NY 14853, J. Engrg. Power, Trans. ASME, 105 (3), pp 551-559 (July 1983) 17 figs, 12 refs

Key Words: Rotors, Unbalanced mass response, Squeeze-film dampers

The steady-state response due to unbalance of a planar rigid rotor carried in a short squeeze film damper with linear centering spring is considered. The damper fluid forces are determined from the short bearing, cavitated (π film) solution of Reynold's equation. Assuming a circular centered orbit, a change of coordinates yields equations whose steady-state response are constant eccentricity and phase angle. Focusing on this steady-state solution results in reducing the problem to solutions of two simultaneous algebraic equations. A method for finding the closed-form solution is presented.

83-2366

Eigensolution Reanalysis of Rotor Dynamic Systems by the Generalized Receptance Method

A.B. Palazzolo, B.P. Wang, and W.D. Pilkey

Southwest Res. Inst., San Antonio, TX 78284, J. Engrg. Power, Trans. ASME, 105 (3), pp 543-550 (July 1983) 3 figs, 4 tables, 21 refs

Key Words: Natural frequencies, Rotors, Receptance method, Eigenvalue problems

A method is presented for efficiently calculating the damped natural frequencies of complex rotor bearings systems. The procedure is applicable to the repeated reanalysis of rotor systems during the search for an optimal design. The generalized receptances used in the method are calculated with a series of formulas that improves the convergence characteristics when only an incomplete set of modes is available. A nonsynchronous gyroscopic rotor example is examined to illustrate the reanalysis procedure.

83-2367

A Discussion on Several Dynamic Problems of Split-shaft Gas Turbines

Ni Wei Tou and Peng Rung

Chinese J. Sci. Instrument, 3 (4), pp 396-401 (1982) CSTA 681-82.77

Key Words: Shafts, Gas turbines, Computer programs

Several problems on the dynamic behavior of split-shaft gas turbines, utilizing a common computer program, are analyzed. The effects of performance points, ratio of inertia moments of power turbine shaft and compressor shaft, heat accumulation ability of regenerator, and parameters of

control loop of adjustable nozzles on dynamic response of split-shaft gas turbines are discussed.

83-2368
The Measurement and Research of Horizontal Vibration on Propulsion Shaft System of Type K Boat
Li Chong Ren
Ship Engrg. (5), pp 43-45 (1982)
CSTA 623.8-82.53

Key Words: Shafts, Marine engines, Vibration measurement

This paper deals with measuring methods for the horizontal vibration of a propulsion shaft system on a type K boat. An analysis of the actual results from the measurement is also given.

83-2369
Thermal Effects on Rotating Shafts Due to Electrical Transients Causing Plastic Deformation
S. Panteliou, N. Aspragathos, and A. Dimarogonas
Machine Design Laboratory, University of Patras, Patras, Greece, Ing. Arch., 53 (3), pp 173-179 (1983) 6 figs, 11 refs

Key Words: Shafts, Torsional vibration, Temperature effects

During transient torsional vibration of rotating shafts, heat is generated which may affect its operational integrity. The shaft modeled as a cylinder of infinite length heated by way of a transient torsional vibration of variable amplitude is investigated and an expression for the maximum surface temperature is obtained. Diagrams with the appropriate dimensionless parameters are presented together with a numerical example corresponding to an existing turbine-generator system. Both plastic deformation and material damping is considered.

83-2370
A New High-Speed Algorithm for Torsional Vibration Problems Applicable to Microcomputers
D.R. Nickerson
Stress Analysis Assoc., Inc., Pasadena, CA, ASME Paper No. 83-DE-4

Key Words: Shafts, Torsional vibration, Natural frequencies, Mode shapes, Algorithms

The Holzer method of calculating torsional shaft frequencies is both tedious and of limited accuracy, especially where multiple mode frequencies are desired. An algorithm is proposed that computes all the modal frequencies rapidly. This algorithm has been implemented for microcomputers with limited memory capacity. This paper describes the algorithm and presents results of calculating several typical problems using a microcomputer program. The program calculates all modal frequencies and will compute selected modal excursions.

83-2371
Optimal Design of Squeeze Film Supports for Flexible Rotors
M.D. Rabinowitz and E.J. Hahn
Hawker DeHavilland Australia, Lidcombe, New South Wales, Australia, J. Engrg. Power, Trans. ASME, 105 (3), pp 487-494 (July 1983) 3 figs, 3 tables, 23 refs

Key Words: Rotors, Flexible rotors, Squeeze film dampers, Damping

Assuming central preloading, operation below the second bending critical speed, and full film lubrication, this paper presents a theoretical model which allows one, with minimum computation, to design squeeze film damped rotors under conditions of high unbalance loading. Closed form expressions are derived for the maximum vibration amplitudes pertaining to optimally damped conditions. The resulting vibration amplitude and transmissibility data of design interest are presented for a wide range of practical operating conditions on a single chart. It can be seen that for a given rotor, the lighter the bearing the more easily one can satisfy design constraints relating to allowable rotor vibration levels and lubricant supply pressure requirements. The data presented are shown to be applicable to a wide variety of rotors, and a recommended procedure for optimal design is outlined.

83-2372
Aeroacoustic Characteristics of a Large Variable-Pitch, Variable-Speed Fan System
P.T. Soderman and K.W. Mort
NASA Ames Res. Ctr., Moffett Field, CA, NASA-TM-84333, 7 pp (Mar 1983)
N83-23113

Key Words: Fans, Blades, Noise generation, Experimental test data

The acoustic and aerodynamic performance of the new drive fans for the NASA Ames 40- by 80-/80- by 120-foot wind tunnel is investigated. Results show that a fan system with variable-speed and variable-pitch rotor blades allows the operator to control noise and energy consumption, at a given mass flow rate, through the choice of blade speed and pitch. An empirical method is described which predicts the sound power of this fan system reasonably well.

83-2373

Dynamic Response of a Centrifugal Liquid Oxygen

T. Shimura and K. Kamijo

Natl. Aerospace Lab., Miyagi, Japan, ASME Paper No. 83-FE-24

Key Words: Pumps, Centrifugal pumps

The dynamic response of a centrifugal liquid oxygen pump with an inducer is examined. Transfer matrix methods, which have been successfully applied to cavitating inducers, are used for the centrifugal pump with an inducer.

83-2374

Whirling and Stability of Flywheel Systems, Part 1: Derivation of Combined and Lumped Parameter Models

G. Ramanujam and C.W. Bert

School of Aerospace, Mech. and Nuclear Engrg., Univ. of Oklahoma, Norman, OK 73019, J. Sound Vib., 88 (3), pp 369-398 (June 8, 1983) 3 figs, 38 refs

Key Words: Flywheels, Natural frequencies, Dynamic stability, Whirling, Lumped parameter method, Combined parameter method

The objective of this paper is to provide a theoretical foundation to predict many aspects of dynamic behavior of flywheel systems when spin-tested with a quill shaft support and driven by an air turbine. Theoretical analyses for the following are presented: determination of natural frequencies (or for brevity critical speeds of various orders), Routh-type stability analysis to determine the stability limits (i.e., the speed range within which small perturbations attenuate rather than cause catastrophic failure), and forced whirling analysis to estimate the response of major components of the system to flywheel mass eccentricity and initial tilt.

83-2375

Whirling and Stability of Flywheel Systems, Part II: Comparison of Numerical Results Obtained with Combined and Lumped Parameter Models

G. Ramanujam and C.W. Bert

School of Aerospace, Mech. and Nuclear Engrg., Univ. of Oklahoma, Norman, OK 73019, J. Sound Vib., 88 (3), pp 399-420 (June 8, 1983) 14 figs, 15 tables, 19 refs

Key Words: Flywheels, Natural frequencies, Dynamic stability, Whirling, Lumped parameter method, Combined parameter method

The theoretical analyses of Part I are applied to some flywheel systems to provide information to designers. The analyses are utilized to study three specific prototype flywheel systems: a multi-material ring type, a constant-thickness-disk ring type, and a tapered-thickness-disk type. The effects of the following flywheel design parameters on system dynamics are investigated: flywheel mass, flywheel diametral and polar mass moments of inertia, location of flywheel diametral and polar mass moments of inertia, location of flywheel mass center from the lower end of the quill shaft, quill shaft length, lower turbine-bearing support stiffness, and equivalent viscous damping coefficient of the external damper.

RECIPROCATING MACHINES

83-2376

Mathematical Investigation of Gas Vibrations in a Four Step Diesel Engine of Commercial Vehicles under Combined Loading (Rechnerische Untersuchung der Gasschwingungen in einem kombiniert aufgeladenen 4-Takt-Dieselmotor für Nutzfahrzeuge)

X. Gao and K. Groth

Institut f. Kolbenmaschinen der Universität Hannover, Germany, Konstruktion, 35 (7), pp 273-278 (July 1983) 13 figs, 1 table, 11 refs

(In German)

Key Words: Diesel engines, Ground vehicles, Commercial transportation, Tuned frequencies

A simplified calculation method for tuning the resonances in combined loading is illustrated by means of an example of a six cylinder four step engine of a commercial vehicle. The calculated results – the pressure and the rate of flow – are compared with published results.

83-2377
Some Aspects of Constant Pressure Turbocharged Marine Diesel Engines of Medium and Low Speed
T. Azuma, T. Yura, and Y. Tokunaga
Kawasaki Heavy Industries, Ltd., Kobe, Japan, J. Engrg. Power, Trans. ASME, 105 (3), pp 697-711 (July 1983) 35 figs, 3 tables, 9 refs

Key Words: Diesel engines, Marine engines, Exhaust systems

The constant pressure turbocharge system is widely used in marine diesel engines because of its high thermal efficiency. This study has been made to establish a simulation system for exhaust gas pulsation of the constant pressure turbocharge system and to clarify its characteristics. This report discusses the high thermal efficiency of this turbocharge system in the range of high mean effective pressure, and shows the advantages of the two-step Lax-Wendroff's method in solving the unsteady flow equations in comparison with the characteristic method. Some characteristics of the pulsation and the unique pulsation resonance in this turbocharge system are presented.

83-2378
Vibration Analysis of Movable Part of Internal Combustion Engine (Part 2. Combined System of Crank Shaft and Flywheel)
A. Nagamatsu and M. Nagaike
Industrial Faculty, Tokyo Inst. of Tech., Meguroku, Tokyo, Japan, Bull. JSME, 26 (215), pp 827-831 (May 1983) 12 figs, 3 tables, 3 refs

Key Words: Internal combustion engines, Crankshafts, Flywheels, Impedance technique, Natural frequencies, Mode shapes, Transfer functions

Natural frequencies, natural modes, and transfer functions of a combination of crankshaft and flywheel are investigated by a reduced impedance method. Theoretical results agree well with experimental results.

POWER TRANSMISSION SYSTEMS

83-2379
In-Flight Computation of Helicopter Transmission Fatigue Life Expenditure
K.F. Fraser
Aeronautical Res. Labs., Melbourne, Australia, J. Aircraft, 20 (7), pp 633-640 (July 1983) 10 figs, 1 table, 5 refs

Key Words: Power transmission systems, Helicopters, Fatigue life

Estimates of the safe fatigue life of critical helicopter transmission components may be made if in-service load data together with component fatigue data are available. Instrumentation has been developed to provide in-flight computation and indication of the current values of fatigue life expended for critical gears in single- or twin-engine helicopter transmission systems. Basic transmission load data in the form of totalized times spent in a number of contiguous torque bands are continually updated and stored during flight. The basic load data together with values of life expenditure for critical gears for the current flight can be automatically printed out after flight. This development opens the way towards fatigue life monitoring of individual transmissions.

METAL WORKING AND FORMING

83-2380
Guidelines for Controlling Drill String Vibrations
D.W. Dareing
Maurer Engineering, Inc., Houston, TX, ASME Paper No. 83-Pet-9

Key Words: Drills, Vibration control

This paper explains the causes of severe drill string vibrations and gives guidelines for controlling these vibrations.

83-2381
Mathematical Description and Analysis of Rotation Accuracy of Machine Tool Spindle
Zhang Hua Rong
JCME, 18 (4), pp 65-73 (1982)
CSTA 621.8-82.97

Key Words: Machine tools

This paper mathematically derives and theoretically analyzes some basic theories of rotation accuracy of a machine tool spindle (mathematical description of spindle error motion, frequency analysis, influence of frequency components on mechanical operation, etc.). Deficiencies of the polar coordi-

nates method which is broadly adopted at present are indicated and the basic theorem of the cartesian coordinates method is presented.

83-2382

The Numerical Analysis of Hobbing Torques (1st Report, On the Hobbing Torques in Various Hobbing Methods)

Y. Umezaki, Y. Furumiya, and T. Suzuki

Kyushu Univ., 6-10-1 Hakozaki, Higashiku, Fukuoka 812 Japan, Bull. JSME, 26 (215), pp 897-904 (May 1983) 15 figs, 4 tables, 3 refs

Key Words: Hobbing, Numerical analysis, Torsional vibration

This paper presents an analytical study of the cross sectional area of cut of the hob tooth and describes simple turning test methods by which specific cutting forces applied to hobbings are obtained.

STRUCTURAL SYSTEMS

BUILDINGS

(Also see No. 2467)

83-2383

On Elasto-Plastic Deformations of Multi-Story Shear Type Structures Due to Earthquake Effect

He Guang Qian

China Civ. Engrg. J., 15 (3), pp 10-19 (1982)

CSTA 624-82.26

Key Words: Buildings, Multistory buildings, Seismic design

The deficiencies inherent in the strength checking method stipulated in the current Code of Aseismic Design are revealed and principles of the deformation checking method are suggested. For evaluation of maximum story drifts of multi-storied shear type structures due to nonlinear seismic responses a simple method is presented for the application of the deformation checking method in aseismic design.

83-2384

Dynamics of Flexible Systems with Partial Lift-Off

I.N. Psycharis

Div. of Engrg. and Appl. Science, California Inst. of Tech., Pasadena, CA, Intl. J. Earthquake Engrg. Struc. Dynam., 11 (4), pp 501-521 (July/Aug 1983) 13 figs, 2 tables, 27 refs

Key Words: Buildings, Multistory buildings, Elastic foundations, Interaction: structure-foundation

The dynamic behavior of a simplified model of a multi-story building, supported by an elastic foundation and allowed to uplift, is examined. The building is modeled by an n-degree-of-freedom oscillator, while the foundation is represented by a viscously damped two-spring model which permits uplift. This model has been shown in previous studies to be an accurate approximation to the more realistic but more complex Winkler foundation. Approximate values for the characteristic frequencies of the interacting system are presented and a simple, first-mode solution is developed.

83-2385

Study of Computer Modeling Formulation and Special Analytical Procedures for Earthquake Response of Multistory Buildings

C.F. Neuss, B.F. Maison, and J.G. Bouwkamp

Bouwkamp (J.G.), Inc., Berkeley, CA, Rept. No. NSF/CEE-83006, 455 pp (Jan 1983)

PB83-204339

Key Words: Buildings, Multistory buildings, Seismic response, Computer-aided techniques

The results of correlative analytical studies performed on five multistory buildings located in seismically active regions of the United States are presented. Several models of each building are formulated to assess the influence of various structural and nonstructural modeling aspects on dynamic properties and seismic response. Aspects such as two-dimensional versus three-dimensional frame modeling, rigid joint zone effects, participation of secondary framing systems, nonstructural slab-girder interaction, infill block walls, and mass modeling variations are considered. Effects of different modeling approaches on analytical results are evaluated and the relative importance of various modeling reinforcements is noted.

FOUNDATIONS

(Also see No. 2426)

83-2386

Dynamic Evaluation of an Embedded Machinery Foundation Supported on Piles Subjected to Coupled Sliding-Rocking Vibration

Bian Shun Dao and Zheng Da Tong
J. Bldg. Structure, 3 (5), pp 68-78 (1982)
CSTA 624.82.76

Key Words: Machine foundations, Pile foundations, Viscoelasticity theory

Formulae for evaluating the dynamic response of an embedded machinery foundation supported on piles subjected to coupled sliding and rocking vibration is presented. The design curves are given to define the effective pile length which depends on the dynamic behavior of subsoil as well as the exciting frequency.

83-2387

Pile Foundation Modelling for Inelastic Earthquake Analyses of Large Structures

S. A. Anagnostopoulos

Inst. of Engrg. Seismology and Earthquake Engrg., Hapsa 1, Thessaloniki, Greece, Engrg. Struc., 5 (3), pp 215-222 (July 1983) 4 figs, 3 tables, 23 refs

Key Words: Pile foundations, Off-shore structures, Seismic analysis, Earthquake response

Modeling of pile foundations for nonlinear earthquake response analyses of steel template offshore structures is examined, related problems are discussed and practical solutions are recommended. A parametric investigation is then used as the basis of assessing the effects of uncertainty in some of the parameters on the response of the foundation and superstructure.

83-2388

Soil-Structure Interaction with Rayleigh Waves

A. Gomez-Masso, J. Lysmer, J.-C. Chen, and H.B. Seed

Berliner Strasse 290, 6050 Offenbach/Main, West Germany, Intl. J. Earthquake Engrg. Struc. Dynam., 11 (4), pp 567-583 (July/Aug 1983) 11 figs, 1 table, 28 refs

Key Words: Interaction: soil-structure, Seismic excitation

Presented is a plane-strain method for soil-structure interaction analysis consisting of the superposition of the free field motions and the interaction motions in a generalized seismic environment. The free field is modeled as a horizontally layered viscoelastic medium and the seismic environment may consist of a combination of S, P and Rayleigh waves. The soil-structure system is modeled with viscoelastic finite elements, transmitting boundaries, viscous boundaries and a three-dimensional simulation.

83-2389

Frequency-Independent Impedances of Soil-Structure Systems in Horizontal and Rocking Modes

M. Ghaffar-Zadah and F. Chapel

Laboratoire de Mecanique des Sols-Structures de l'Ecole Centrale des Arts et Manufactures, 92290 Chatenay Malabry, Paris, France, Intl. J. Earthquake Engrg. Struc. Dynam., 11 (4), pp 523-540 (July/Aug 1983) 16 figs, 5 tables, 9 refs

Key Words: Interaction: soil-structure, Buildings, Seismic response, Mechanical impedance

A new method developed for most dynamic soil-structure interaction problems is presented. The key idea is to retain for the frequency-independent impedances values computed for the fundamental frequency of the soil-structure system; thus these values include the dynamic characteristics of the whole soil-structure system and lead to a satisfactory approximation of the exact solution over a wide frequency range. The method is developed here for the horizontal and rocking modes of a structure with a circular base resting on a homogeneous halfspace. Numerical applications are given for a simple linear oscillator in order to make possible a thorough parametric study. The response of some idealized building-foundation systems to harmonic excitation or to a seismic input is examined in order to illustrate the efficiency of the proposed model.

UNDERGROUND STRUCTURES

83-2390

Noise Control of an Underground Mine Personnel Carrier

A.G. Galaitsis and T.G. Bobick

Bolt Beranek and Newman, Inc., 10 Moulton St., Cambridge, MA 02238, Noise Control Engrg., 21 (1), pp 4-9 (July/Aug 1983) 9 figs, 4 refs

Key Words: Underground structures, Mines (excavations), Interior noise, Noise reduction

The interior noise of a mine-operated rail personnel carrier (mantrip vehicle) is reduced by replacing some standard

components with acoustically treated components. The latter included a softer suspension, softer motor mounts, damped panels, sound-absorbing motor enclosures and helical gears. Depending on operating conditions, the modified vehicle was 6 to 7.5 dB(A) quieter than an unquieted mantrip. The noise level in the mantrip interior was reduced to approximately 85 dB(A) at an average vehicle speed.

HARBORS AND DAMS

83-2391

On Dynamic Test of Several Arch Dams

Chen Hou Qun, et al

J. of Hydraulic Engrg., (11), pp 22-32 (1982)

CSTA 627.82.127

Key Words: Dams, Dynamic tests, Seismic analysis

This paper presents achievements obtained from aseismic research made on Baishan, Longyangxia and Ertan Arch Dams. General problems encountered in the aseismic behavior of arch-gravity dams are investigated.

83-2392

Cavitation in Fluid-Structure Response (with Particular Reference to Dams under Earthquake Loading)

O.C. Zienkiewicz, D.K. Paul, and E. Hinton

Univ. College of Swansea, Swansea, UK, Intl. J. Earthquake Engrg. Struc. Dynam., 11 (4), pp 463-481 (July/Aug 1983) 11 figs, 24 refs

Key Words: Interaction: structure-fluid, Cavitation, Dams, Earthquake response, Blast response, Seismic response

A general procedure for dealing with coupled fluid-structure interaction under dynamic load is presented. This incorporates a facility for dealing with a cavitating fluid and is based on the Newton displacement potential. Several solutions are obtained for two-dimensional gravity dam problems illustrating the effects of cavitation on earthquake response and blast loading.

CONSTRUCTION EQUIPMENT

83-2393

Study of Physical and Mechanical Properties on Vibration of Paddy and Wheat Crops

Wang Yue and Wu Shu Tian

Trans. of Chinese Soc. of Agri. Mech., (3), pp 42-52 (1982)

CSTA 621.8-82.85

Key Words: Agricultural machinery

Research has verified that crops in a head-feeding threshing cylinder have a vibratory form of motion. Physical and mechanical properties of vibration for paddy and wheat crops are researched, and measurements taken (geometrical dimensions relating to vibration, weight, rigidity, damping, etc.). The natural frequencies and normal vibratory modes in ear and stalk systems for some lower steps under varied conditions (depending on varied boundary conditions) are measured. Theoretical calculations and analyses are made using a mathematical mode on a computer. The result of the tests and theoretical calculations indicates that, similar to the physical and mechanical characteristics of the crops, the performance of mechanical vibration is also one of inherent properties for each crop and has definite statistical regularity.

POWER PLANTS

(Also see Nos. 2435, 2477, 2517)

83-2394

Impacting of Fuel Assemblies in a Horizontal Seismic Analysis of a Reactor Core

M.A. Johnson

Combustion Engrg., Inc., Windsor, CT, ASME Paper No. 83-NE-8

Key Words: Nuclear reactor components, Seismic analysis

The development of a fuel assembly model used for seismic analysis of fuel in a nuclear reactor is described with emphasis on the impact representation. Two types of fuel assembly impact situations are recognized. Each type has a different load path within the fuel assembly.

83-2395

Determination of Threshold Values for Operating Transients via 3-D Parametric Analysis

P.O. Raju, G. Baylac, and C. Faidy

Teledyne Engrg. Services, Waltham, MA, ASME Paper No. 83-NE-12

Key Words: Nuclear power plants, Fatigue life, Internal pressure, Temperature effects

The threshold values of operating parameters such as internal pressure and temperature fluctuations are determined in order that the monitoring of these parameters can be optimized in an operating nuclear power plant on the basis that these fluctuations would not adversely affect the structural integrity and/or fatigue life of the systems and components involved.

83-2396

A Method for In-Situ Test and Analysis of Nuclear Plant Equipment

J.F. Unruh, E.Z. Polch, and D.D. Kana

Southwest Res. Inst., San Antonio, TX, ASME Paper No. 83-PVP-21

Key Words: Nuclear power plants, Modal analysis

The procedures necessary to develop a required response spectrum for an instrument located at an elevated position within a base fixed enclosure from modal analysis parameter measurements on the enclosure while installed in an operating nuclear plant is addressed.

83-2397

Development of Fragility Descriptions of Equipment for Seismic Risk Assessment of Nuclear Power Plants

G.S. Hardy and R.D. Campbell

Structural Mechanics Associates, Inc., Newport Beach, CA, ASME Paper No. 83-PVP-13

Key Words: Nuclear power plants, Seismic response

Probabilistic risk assessment of a nuclear power plant for postulated hazard requires the development of fragility relationships for the plant's safety-related equipment. Some general results and conclusions concerning the development of these seismic fragility levels are presented.

83-2398

Response of a Nuclear Power Plant on Aseismic Bearings to Horizontally Propagating Waves

J.P. Wolf, P. Obernhuber, and B. Weber

Electrowatt Engrg. Services Ltd., 8022 Zürich, Switzerland, Intl. J. Earthquake Engrg. Struc. Dynam., 11 (4), pp 483-499 (July/Aug 1983) 20 figs, 3 tables, 12 refs

Key Words: Power plants (facilities), Nuclear power plants, Seismic isolation

The nuclear island of Koeberg with a large basemat, a nonlinear base isolation effective in the horizontal direction only, founded on rock, is analyzed for inclined body waves and for a combination of surface and body waves associated with prescribed horizontal and vertical components of the control motion.

83-2399

A Methodology for the Probabilistic Analysis of Pressurized Water Reactor Vessel Integrity During Pressurized Thermal Shock Transients

P.S. Jackson, D.S. Moelling, F.J. Berte, and J.J. Herbst

Combustion Engineering, Inc., Windsor, CT, ASME Paper No. 83-PVP-1

Key Words: Nuclear reactors, Crack propagation

An important feature of the probabilistic approach is the ability to assign credit for in-service inspection results within a logical and consistent framework. These results can be used to lower the estimated probability of crack extension and can provide margin for acceptable operation in terms of RT_{NDT}.

83-2400

Development of Crack Growth Model for the Analysis of Reactor Vessel Pressurized Thermal Shock

H.C. Rhee

Conoco R&D Ctr., Ponca City, OK, ASME Paper No. 83-PVP-57

Key Words: Nuclear reactors, Crack propagation

The fracture parameter distributions along the crack fronts of both continuous and elliptical flaws in a reactor vessel wall under various forms of pressurized thermal shock transients are studied. An evaluation of the sensitivity of fracture parameter distributions to the internal pressure and material property variations due to fluence attenuation through the reactor vessel wall is also presented.

83-2401

Seismic Analysis of a Nonlinear Airlock Door System

S.N. Huang

Westinghouse Hanford Co., Richland, WA, ASME Paper No. 83-PVP-48

Key Words: Doors, Containment structures, Seismic analysis

The containment equipment airlock door of a test facility uses screw-type actuators as a push-pull mechanism for closing and opening operations. Seismic analyses, using the time history method, were conducted to determine the seismic loads on screw-type actuators. Several sizes of actuators were examined. Procedures for determining the final optimum design are discussed.

OFF-SHORE STRUCTURES

(Also see No. 2443)

83-2402

The Dynamics of a Flexible Articulated Column in Waves

R. Eatock Taylor, K.R. Drake, and P.E. Duncan
Dept. of Mech. Engrg., Univ. College London, London, UK, Engrg. Struc., 5 (3), pp 181-198 (July 1983) 15 figs, 11 refs

Key Words: Off-shore structures, Beams, Columns, Harmonic excitation, Fluid-induced excitation, Water waves

A theoretical analysis is developed for the dynamic response of a flexible articulated column excited harmonically by regular waves. Viscous effects in the fluid are neglected, but the hydrodynamic loading is evaluated by means of a complete wave diffraction and radiation analysis. The column is idealized by the Euler-Bernoulli beam theory. Theoretical results for a doubly articulated column are successfully compared with experimental data from a model tested in random waves.

VEHICLE SYSTEMS

GROUND VEHICLES

(Also see Nos. 2421, 2428, 2554)

83-2403

Eulerian Dynamics of a Profiled Wheelset on a Profiled Straight Track

M. Decuyper
Aspirant au Fonds National de la Recherche Scientifique, Universite Catholique de Louvain, Louvain-la-Neuve, Belgium, Intl. J. Vehicle Des., 4 (5), pp 540-555 (Sept 1983) 3 figs, 3 tables, 4 refs

Key Words: Railroad trains, Wheelsets

This paper is devoted to the adaptation of the Eulerian equations of motion of an idealized model of wheelset, called a bicone, to the case of a profiled wheelset on profiled rails. The adaptation is performed from the fundamental kinematical relationships by introducing a modeling coefficient which is computed numerically by the extended envelope method. The equations are then derived following the same procedure as for the bicone, using the same model of creep contact forces.

83-2404

Validation of Railway Vehicle Lateral Dynamics Models

R.J. Gostling and N. Cooperrider
Track Res. Unit, BR R & D Div., Derby, UK, Vehicle Syst. Dynam., 12 (4-5), pp 179-202 (Aug 1983) 86 refs

Key Words: Railroad trains, Mathematical models

The general form of the railway vehicle lateral dynamic predictions are proven. If wheels are coned, rails are of uniform cross-section, and suspensions are linear, then good predictions can be obtained. If wheels are not coned, and rail sections vary, but the suspension is relatively linear, as in modern vehicles, it is still possible to obtain good predictions of critical speed for flexible suspensions.

83-2405

Automotive Stability and Handling Dynamics in Cornering and Braking Maneuvers

F. Uffelmann
Audi NSU Auto Union AG, Ingolstadt, West Germany, Vehicle Syst. Dynam., 12 (4-5), pp 203-223 (Aug 1983) 14 figs, 10 refs

Key Words: Ground vehicles, Automobiles, Cornering effects, Braking effects

Automotive steering behavior is classified for steady-state cornering and the definitions of over-/understeer and stability/instability are well known. These definitions are

applied to combined cornering and braking maneuvers; i.e., to extend the criteria to quasi-steady-state conditions. The vehicle behavior is analyzed using the cornering stiffness of the axles and front/rear cornering stiffness ratio. The paper deals with two groups of vehicles: single vehicles (passenger cars) and combinations (passenger car/caravan and tractor/semitrailer).

83-2406

Suspension Bounce Response of Canadian MAGLEV Vehicle under Guideway Excitations. Part 2: Stochastic Modeling and Analysis

M. Kotb, T.S. Sankar, and M. Samaha
Dept. of Mech. Engrg., Concordia Univ., Montreal, Quebec, Canada, J. Vib. Acoust. Stress Rel. Des., Trans. ASME, 105 (2), pp 261-266 (Apr 1983) 7 figs, 6 refs

Key Words: Ground vehicles, Ground effect machines, Magnetic vehicle suspensions, Interaction: vehicle-guideway

The Canadian MAGLEV vehicle is subjected to a combination of periodic as well as dominant random disturbances from the guideways. Appropriate mathematical modeling of the input process is presented in terms of spectral density function which is further modeled as the output of a second order linear filter under a white noise input for easy analysis. The combined filter-vehicle stochastic equations are solved numerically and the suspension bounce acceleration behavior for different system parameters is presented.

SHIPS

(See Nos. 2368, 2418)

AIRCRAFT

(Also see Nos. 2361, 2379, 2431, 2433, 2504, 2507)

83-2407

Strength of Focused Sonic Booms for the Example of a Straight Level Flight (Stärke fokussierter Überschallknalle am Beispiel eines geradlinigen Fluges in konstanter Höhe)

H. Schilling
Rheinmetall GmbH, Ulmenstrasse 125, D-4000 Düsseldorf, Fed. Rep. Germany, Ing. Arch., 53 (3), pp 181-195 (1983) 14 figs, 9 refs
(In German)

Key Words: Aircraft noise, Sonic boom

For the example of a straight, accelerated level flight at constant height (homogeneous atmosphere) the location of superbooms on the ground are calculated using geometric acoustics. A simple inequality is derived which has to be satisfied by the flight parameters in order to produce such focused sonic booms at all. An expression for the pressure jump of a superboom is given, and a focus factor is defined as the pressure jump of the superboom divided by the pressure jump of a sonic boom at the same place generated by a level flight with the same Mach number. Comparisons with experiments show very satisfactory agreement.

83-2408

System Identification and Aircraft Flutter

Zhang Ling Mi
Acta Aeron. et Astron. Sinica, 3 (3), pp 33-41 (1982)
CSTA 629.1-82.27

Key Words: Aircraft vibration, Flutter, System identification technique

After reviewing the application of system identification to aircraft flutter research, three methods of system identification are presented. Emphasis is on the main points of algorithm identification and its theoretical basis. Problems related to data processing are also discussed. The transfer function method based on complex modal analysis and optimization technique can identify all of the modal parameters accurately. This method has been applied successfully to the flutter model test of a wing with external bodies and can be extended to the cases of wind tunnel and flight tests which provide response data only.

83-2409

Rigid-Body Structural Mode Coupling on a Forward Swept Wing Aircraft

G.D. Miller, J.H. Wykes, and M.J. Brosnan
Rockwell International, El Segundo, CA, J. Aircraft, 20 (8), pp 696-702 (Aug 1983) 18 figs, 9 refs

Key Words: Aircraft, Flutter, Active flutter control

Aeroelastic studies of a free-flying forward swept wing (FSW) aircraft have shown that the static aeroelastic divergence exhibited on cantilevered FSW's is replaced with a low-fre-

quency flutter mode due to coupling between the wing divergent mode and the aircraft short-period mode. Studies of possible means of increasing this flutter speed have indicated that adding structural stiffness would result in prohibitive weight or drag penalties. An active flutter control system that employed the existing stability augmentation system of the aircraft was shown to increase the flutter speed by 40% without a performance penalty.

83-2410

Study on Longitudinal Dynamic Characteristics of Pilot-airplane System – Approach to the Method for Studying PIO Problem

Chen Ting Nan and Li Chun Zhu

Acta Aeron. et Astron. Sinica, 3 (4), pp 12-20 (1982) CSTA 629.1-82.36

Key Words: Aircraft, Longitudinal response

In order to meet the needs for studying PIO (pilot-induced oscillation) and the influence of control system nonlinearity (clearance, friction, etc.), a dynamic structure diagram and an analog structure diagram in longitudinal motion of pilot-control-airframe with nonlinearity are derived, and a new method is provided for studying the PIO problem. Computations are carried out on a DMJ-3A analog computer for three cases: the moment arm at normal state (short arm), the moment arm at trouble state (long arm), and the moment arm still at trouble state (long arm) wihout pilot's correction, for a fighter flying at low level and high speed.

83-2411

Application of Laser Holographic Interferometry to Vibration Analysis of Aerocraft Beam Structure Model

Jin Guan Chang, et al

Acta Aeron. et Astron. Sinica, 3 (4), pp 41-46 (1982) CSTA 629.1-82.40

Key Words: Aircraft, Vibration analysis, Holographic techniques, Interferometric techniques, Beams

This paper describes the use of laser holographic interferometry in vibration analysis of aircraft beam structure models. Various vibration modes for two kinds of simplified models (three-beam and five-beam) of the same wing have been photographed by means of laser holography. Their natural frequencies and node distributions are obtained from theoretical calculations.

83-2412

Transonic Flutter Model Study of a Supercritical Wing and Winglet

C.L. Ruhlin, F.J. Rauch, Jr., and C. Waters

NASA Langley Res. Ctr., Hampton, VA, J. Aircraft, 20 (8), pp 711-716 (Aug 1983) 10 figs, 1 table, 18 refs

Key Words: Aircraft wings, Flutter

A scaled flutter model – a 1/6.5-size, semispan version of a supercritical wing proposed for an executive-jet transport airplane – was tested cantilever-mounted with a normal wingtip, a wingtip with winglet, and a normal wingtip ballasted to simulate the winglet mass properties. Flutter and aerodynamic data were acquired at Mach numbers (M) from 0.6 to 0.95. Comparisons of measured static aerodynamic data with predicted data indicated that the model was aerodynamically representative of the airplane SCW.

83-2413

Formulation and Solution of Rotary-Wing Aeroelastic Stability and Response Problems

P.P. Friedmann

Mechanics and Structures Dept., Univ. of California at Los Angeles, Los Angeles, CA 90024, Vertica, 7 (2), pp 101-141 (1983) 30 figs, 124 refs

Key Words: Helicopters, Propeller blades, Aerodynamic loads

The state of the art in the formulation and solution of rotary-wing aeroelastic stability and response problems is reviewed in detail. The approximations used in the structural, inertia and aerodynamic operators are discussed. The important role of geometric nonlinearities, due to moderate deflections, and aerodynamic stall in the aeroelastic stability and response problem are identified. Formulation of coupled rotor/fuselage problems is described for both air and ground resonance type problems.

83-2414

Investigation of the Stall Flutter of an Airfoil with a Semi-Empirical Model of 2-D Flow

R. Dat and C.T. Tran

Office National d'Etudes et de Recherches Aerospatiales (ONERA), 92320 Chatillon, France, Vertica, 7 (2), pp 73-86 (1983) 8 figs, 6 refs

Key Words: Airfoils, Flutter, Helicopters, Propeller blades, Blades

The stability of an airfoil mounted on an axis of oscillation, with one degree of freedom in pitch, is studied with a semi-empirical model which was developed in order to predict the unsteady aerodynamic loads on a helicopter blade section performing large amplitude flap and pitch oscillations. The stability of small amplitude oscillations is shown to depend on the reduced frequency, mean incidence and chordwise location of the axis of oscillation.

MISSILES AND SPACECRAFT

(Also see No. 2529)

83-2415

On Stabilization and Pole Assignment of Elastic Vibration System

Feng De Xing and Zhu Guang Tian

Scientia Sinica, 25 (5), pp 548-560 (1982)

CSTA 531-82.126

Key Words: Spacecraft, Vibration control

The stabilization problem of the elastic vibration system for a space vehicle with slender body is considered. It is shown that such a stabilization problem can be reduced into one of a beam with two fixed ends, and an explicit expression of the asymptotic attitude is given. The pole assignment of the system is discussed and a formula is obtained.

BIOLOGICAL SYSTEMS

HUMAN

83-2416

Subjective Response to Noise in Rural Villages, Particularly from Road Traffic

M.M. Hawkins and J.B. Large

Inst. of Sound and Vib. Res., Univ. of Southampton, Southampton S09 5NH, UK, J. Sound Vib., 88 (3), pp 321-331 (June 8, 1983) 5 figs, 2 tables, 15 refs

Key Words: Traffic noise, Human response

Subjective response to noise, particularly from road traffic, arising from 10 villages in rural Hampshire and Wiltshire is compared with response from a previous survey carried out on a representative sample of adults resident in England. This English sample consisted of individuals occupying, for the most part, urban and suburban areas.

83-2417

Evaluation of Human Exposure to the Noise from Large Wind Turbine Generators

K.P. Shepherd, F.W. Grosveld, and D.G. Stephens

The Bionetics Corp., 18 Research Dr., Hampton, VA 23666, Noise Control Engrg., 21 (1), pp 30-37 (July/Aug 1983) 13 figs, 13 refs

Key Words: Wind turbines, Noise generation, Human response

A procedure to evaluate human exposure to the noise from large wind turbine generators is developed. The evaluation is based on the noise at the receiver location, which is measured directly or inferred from a knowledge of the noise at the turbine site along with an estimate of the atmospheric propagation effects. The evaluation involves a comparison of the noise and any noise induced building vibration with the human perception thresholds which are developed for wind turbine noise.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

(Also see No. 2398)

83-2418

The Choice and Application of Vibration Isolating Equipment and Materials for Electronic Apparatus in Ships

Wang Guang and Yu Xiang Feng

Ship Engrg. (5), pp 46-50 (1982)

CSTA 623.8-82.54

Key Words: Vibration isolation, Damping effects, Equipment response, Shipboard equipment response

Analyses and comparisons are made for normal isolating equipment and material on the basis of the general vibration isolation theory. The function of damping on isolating vibration and depressing resonance is also discussed.

83-2419

Experimental Investigation of Inertia Effects in One-Dimensional Metal Ring Systems Subjected to End Impact -- 1. Fixed-Ended Systems

S.R. Reid and T.Y. Reddy

Dept. of Engrg., Univ. of Aberdeen, Aberdeen AB9 1AS, UK, Intl. J. Impact Engrg., 1 (1), pp 85-106 (1983) 12 figs, 3 tables, 16 refs

Key Words: Energy absorption, Tubes, Rings, Experimental test data

Arising from an interest in the use of laterally compressed metal tubes and rings as impact energy absorbing components, the role played by inertia in the deformation of systems of such components is examined experimentally. Crossed-layered systems of metal tubes undergoing low speed impact in a drop hammer are considered briefly. The paper is principally concerned with the response of one-dimensional ring systems tested in a simple high speed impact apparatus over a range of conditions. An account is given of various features of the modes of deformation which occur and an explanation is offered which highlights the mechanisms controlling the deformation process.

83-2420

Vehicle Suspension Dynamic Optimization

E.J. Haug, V.N. Sohoni, S.S. Kim, and H.-G. Seong

College of Engrg., Univ. of Iowa, Iowa City, IA, 29 pp (Jan 1983)

AD-P000 964

Key Words: Suspension systems (vehicles), Optimization

A vehicle suspension dynamic response design sensitivity analysis and optimization technique is presented and illustrated. Dynamic response measures included in the formulation, for use as the objective function or as constraints, include driver absorbed power, driver peak acceleration, and suspension element travel. Design parameters available to the designer include suspension spring and damper characteristics, suspension dimensions, and parameters in feedback control suspension subsystems.

83-2421

Optimum Design of Hydraulic Shock Absorbers (2nd Report, Using Unknown Parameters Comprising Piecewise Linear Resisting Force, Spring Constants, and Damping Coefficient)

K.-I. Maemori

Hachinohe Inst. of Tech., 88-1, Obiraki, Myo, Hachinohe, Japan, Bull. JSME, 26 (215), pp 864-872 (May 1983) 17 figs, 18 refs

Key Words: Energy absorption, Bumpers, Optimum design, Spring constants, Damping coefficients, Collision research (automotive), Crashworthiness

A hydraulic shock absorber in a mechanical system was designed using a SUMT for optimum response to velocity shock. The resisting force of such a shock absorber is expressed as the product of the shock absorber velocity squared and a coefficient expressed in terms of the shock absorber displacement. Unknown parameters for optimum design include the piecewise linear resisting force of the shock absorber, spring constants, and a damping coefficient. As examples of the mechanical system using the shock absorber, springs, and damping to be optimized, high-speed models of car-to-barrier collisions are considered.

83-2422

Forced Vibrations of a Beam with a Non-Linear Dynamic Vibration Absorber

H. Kojima and H. Saito

Dept. of Mech. Engrg., Gunma Univ., Kiryu, Gunma, Japan, J. Sound Vib., 88 (4), pp 559-568 (June 22, 1983) 9 figs, 9 refs

Key Words: Dynamic vibration absorption (equipment), Nonlinear dynamic absorbers, Periodic excitation, Beams, Forced vibration

Forced vibrations of a simply supported beam having an attached nonlinear dynamic vibration absorber and excited by sinusoidal motion of its supporting base are investigated analytically. The absorber produces a hardening spring force in the form of a cubic curve. The results of the present analysis are applied to a magnetic nonlinear dynamic absorber, and the optimum tuning and optimum damping for the absorber are obtained by the simplex method.

83-2423

Application of Multiple Dynamic Absorbers to Reduce the Vibration Level of a Complex Cantilever Structure

Tian Qian Li

Acta Aeron. et Astron. Sinica, 3 (3), pp 42-49 (1982)

CSTA 629.1-82.28

Key Words: Dynamic absorbers, Cantilever beams, Vibration control

The application of multiple dynamic absorbers to reduce the vibration level in a complex cantilever structure is proposed. Six absorbers are hung on a given section of the structure to overcome the drawback of the usual tuned absorbers; i.e., excessive sensitivity to the tuning parameters.

83-2424
Working of Magnetic Dynamic Absorber (Sub-harmonic Vibration)
Y. Kurakake and Y. Hara
Sasebo Technical College, 1-1, Okishin, Sasebo-City, Nagasaki, Japan, Bull. JSME, 26 (215), pp 848-855 (May 1983) 6 figs, 4 refs

Key Words: Absorbers (equipment), Magnetic absorbers, Dynamic absorbers, Subharmonic oscillations

In a vibrating system (principal mass) attached on a damped magnetic dynamic absorber containing two fixed side magnets and an absorber magnet (floating mass) which is subjected to an external periodic force, the amplitude of the principal mass will be decreased, but by the character of the magnets in the magnetic dynamic absorber, a nonlinear motion occurs in the vibrating system and also sub-harmonic vibrations are induced in it. In this paper, the sub-harmonic vibrations, especially the 1/2 subharmonic and the 1/3 subharmonic vibrations which occur in a vibrating system, are analyzed, the characteristic curves of the amplitudes are obtained, and the stabilities of those vibrations of the system are discussed.

83-2425
State-Space Aeroelastic Modeling and Its Application in Flutter Calculation
Lu Shu Quan
Acta Aeron. et Astron. Sinica, 3 (4), pp 1-10 (1982)
CSTA 629.1-82.35

Key Words: Active flutter control

Three rational approximations of unsteady loads (Roger's, matrix Pade's and Karpel's) are reviewed for designing the control law of an active flutter suppression system. Three indices for evaluating the fitting accuracy are proposed.

83-2426
On the Suppression of Ground Vibration by Active Force Controller (Suppression of Exciting Force by Feedforward Control)
N. Tanaka and Y. Kikushima
Mech. Engrg. Lab., 1-2 Namiki Sakuramura Niihari-gun Ibaraki-ken, Japan, Bull. JSME, 26 (215), pp 839-847 (May 1983) 21 figs, 5 refs

Key Words: Ground vibration, Vibrating foundations, Vibration control, Active force control

For the purpose of suppressing ground vibration as a public nuisance produced by vibrating machines (forging machines, press machines, etc.), this paper presents a new type active force controller. The principle of the active force controlling method is shown, and system equations are derived. The characteristics and the design parameters of the active force controller are presented.

SPRINGS

83-2427
Out-of-Plane Moment in Helical Springs
J.F. Bish and H.W. Brunsveld van Hulten
Pan-Consult B.V., Delft, Holland, Forsch. Ingenieurwesen, 49 (4), pp 127-130 (1983) 7 figs, 2 refs

Key Words: Springs, Helical springs

The existence of an out-of-plane moment accompanying the twisting moment is proven in the case of a close-coiled helical spring under load. The correct expressions for the stiffness and the deflection are derived. Simplification of expressions for maximum stress is given.

TIRES AND WHEELS
(Also see No. 2430)

83-2428
The Analysis and Measurement of the Dynamic Characteristics of a Wheeled Tractor
Xue Pei Yun, et al
Trans. of Chinese Soc. of Agri. Mach. (4), pp 1-13 (1982)
CSTA 631.3-82.10

Key Words: Tractors, Tires, Interaction: tire-pavement

A mathematical model is established for a wheeled tractor. The power spectrum matrix for the terrain excitation to tires and response power spectra for vertical acceleration at mass center and at any point on the tractor are derived. Given the tractor parameters and working conditions, the response power spectrum at any point on a wheeled tractor can be obtained. Tests show that the vertical acceleration of the front axle is mainly induced by the road input to the front tires.

BLADES

83-2429

Blade Loss Transient Dynamic Analysis of Turbomachinery

M.J. Stallone, V. Gallardo, A.F. Storace, L.J. Bach, G. Black, and E.F. Gaffney

General Electric Co., Cincinnati, OH, AIAA J., 21 (8), pp 1134-1138 (Aug 1983) 13 figs, 1 table, 8 refs

Key Words: Blade loss dynamics, Aircraft engines, Turbomachinery

This paper reports on work completed to develop an analytical method for predicting the transient nonlinear response of a complete aircraft engine system due to the loss of a fan blade, and to validate the analysis by comparing the results against actual blade loss test data. The solution, which is based on the component element method, accounts for rotor-to-casing rubs, high damping, and rapid deceleration rates associated with the blade loss event.

83-2430

An Investigation into Distribution Parameters of Steam Turbine Blade and Wheel Vibration Measurements

M.U. Farid

IMechE., Proc., 197, pp 117-125 (June 1983) 6 figs, 2 tables, 5 refs

Key Words: Blades, Wheels, Steam turbines, Vibration measurement

This investigation was carried out to find a concise and meaningful way of describing the steam turbine blade and wheel vibration measurements which would enable predictions from experimental to production wheels to be made with known level of confidence. The analysis concentrated on stage six of low-pressure turbine wheels. Two types of wheels, similar in every respect except roof fixation, were used. The method of obtaining and interpreting static and dynamic blade and wheel vibration frequency measurements is described.

83-2431

Transonic Effects on Helicopter Rotor Blades

H. Huber, V. Mikulla, and H. Stahl

Messerschmitt-Bolkow-Blohm GmbH, Munich, Fed. Rep. Germany, Vertica, 7 (2), pp 87-100 (1983) 25 figs, 13 refs

Key Words: Blades, Propeller blades, Helicopters, Aerodynamic loads

This paper summarizes the basic transonic environment of the rotor and describes and discusses the most important consequences on helicopter high speed behavior. A survey of the most advanced numerical methods, capable of partially calculating the supercritical flow over the rotor blade is presented. Results of computational and experimental (model testing) investigations are shown, indicating that unsteadiness is a major feature of the transonic rotor flow.

83-2432

Structural Element and Real Blade Impact Testing. Volume 1

R.S. Bertke

Res. Inst., Univ. of Dayton, OH, Rept. No. UDR-TR-82-03-VOL-1, AFWAL-TR-82-2121-VOL-1, 469 pp (Jan 1983)

AD-A127 744

Key Words: Blades, Fan blades, Beams, Cantilever beams, Plates, Cantilever plates, Impact tests, Experimental test data

This report gives damage results of an experimental program concerned with performing nonrotating bench impact tests on test specimens ranging from simple cantilevered beams and plates to real fan blades.

83-2433

Optimal Higher Harmonic Blade Pitch Control for Minimum Vibratory Vertical Hub Force of a Hinged Rotor

L. Beiner

Ben Gurion Univ., Beer Sheva, Israel, Z. Flugwiss, 7 (3), pp 203-212 (1983) 6 figs, 10 refs

Key Words: Helicopters, Blades, Propeller blades, Harmonic response

The paper presents a general analytical solution to the problem of finding the optimal b/rev blade feathering which minimizes the b-th blade lift harmonic of a given hinged rotor under a given trimmed flight condition. It is proven that the resulting minimum is zero, thus suppressing the aerodynamic component of the b/rev hub vertical force for a b-bladed rotor.

83-2434

Unsteady Aerodynamics and Gapwise Periodicity of Oscillating Cascaded Airfoils

F.O. Carta

United Technologies Res. Ctr., East Hartford, CT 06108, J. Engrg. Power, Trans. ASME, 105 (3), pp 565-574 (July 1983) 14 figs, 13 refs

Key Words: Blades, Airfoils, Cascades, Aerodynamic instability

Tests were conducted on a linear cascade of airfoils oscillating in pitch to measure the unsteady pressure response on selected blades along the leading edge plane of the cascade and over the chord of the center blade. The pressure data were reduced to Fourier coefficient form for direct comparison and were also processed to yield integrated loads and, particularly, the aerodynamic damping coefficient. In addition, results from two unsteady theories for cascaded blades with nonzero thickness and camber were compared with the experimental measurements.

BEARINGS

(Also see No. 2533)

83-2435

Seismic Evaluation of a Large Nuclear Pump Bearing Using Nonlinear Dynamic Analysis

K.A. Huber and M.S. Hugins

Borg-Warner Corp., Carson, CA, ASME Paper No. 83-PVP-52

Key Words: Bearings, Pumps, Nuclear reactor components, Seismic analysis

Hydrostatic bearings of a large vertical pump using sodium as the lubricant were critically examined to determine their ability to withstand seismic loads. Initial linear dynamics analyses predicted journal displacements to exceed bearing clearance by a ratio of 3:1.

83-2436

A Study of Elastohydrodynamic Lubrication of a Centrally Loaded 120 Arc Partial Bearing in Different Flow Regimes

S.C. Jain, R. Sinhasan, and D.V. Singh

Dept. of Mech. and Industrial Engrg., Univ. of Roorkee, India, IMechE., Proc., 197, pp 97-108 (June 1983) 18 figs, 1 table, 26 refs

Key Words: Bearings, Fluid film bearings, Elastohydrodynamic properties

The elastic deformation of the bearing liner is considered in determining the static and dynamic performance characteristics of the centrally loaded 120° arc bearing for eccentricity ratio up to 0.8 and mean Reynolds number up to 7500. Using the finite element method, the pressure distribution in the fluid film and the elastic deformation in the bearing shell are obtained by solving the Reynolds equation and the three-dimensional elasticity equations iteratively.

83-2437

High-Speed Motion Picture Camera Experiments of Cavitation in Dynamically Loaded Journal Bearings

B.O. Jacobson and B.J. Hamrock

NASA Lewis Res. Ctr., Cleveland, OH 44135, J. Lubric. Tech., Trans. ASME, 105 (3), pp 446-452 (July 1983) 13 figs, 6 refs

Key Words: Bearings, Journal bearings, Cavitation, Experimental test data, Photographic techniques

Cavitation has an effect on both the power loss and stability of a bearing. A bearing without cavitation can very well be unstable (vibrating) for the same working conditions where a cavitating bearing is stable. A high-speed camera was used to investigate cavitation in dynamically loaded journal bearings. Analysis is given to support the experimental findings for both gas and vapor cavitation.

83-2438

An Experimental Study of the Stability of High-Speed Aerostatic Journal Bearings

Yu Jang Jun and Wang Zhi Hung
Chinese J. of Mech. Engrg., 18 (4), pp 8-20 (1982)
CSTA 621.8-82.91

Key Words: Bearings, Journal bearings, Whirling

Changes of whirl amplitudes with rotational frequencies were measured for aerostatic journal bearings running from zero to 240,000 rpm on rigid support. The experimental analyses of the effects of the supply pressure, bearing clearance, rotor unbalance, etc. on the stability under high-speed operations were conducted. A comparison of high-speed characteristics of five bearing configurations; i.e., slot-fed bearings, orifice compensated bearings, tangentially-fed bearings, etc. was made.

83-2439

The Onset of Whirl Instability in Journal Bearings of Various Bore Shapes and Groove Sizes

M. Akkök and C.M.McC. Ettles

Mech. Engrg. Dept., The Middle East Technical Univ., Ankara, Turkey, J. Lubric. Tech., Trans. ASME, 105 (3), pp 342-352 (July 1983) 15 figs, 21 refs

Key Words: Bearings, Journal bearings, Whirling, Geometric effects

Experimental results are given for load capacity and whirl onset in journal bearings of circular, elliptical and offset halves bore shape. The general validity of the linearized model for predicting whirl is confirmed experimentally.

83-2440

Nonlinear Dynamic Characteristics of Finite Journal Bearings

G.S. Ritchie

Mech. Engrg. Lab., GEC Power Engineering, Ltd., Whetstone, Leicester, UK, J. Lubric. Tech., Trans. ASME, 105 (3), pp 375-376 (July 1983) 8 refs

Key Words: Bearings, Journal bearings, Nonlinear theories

An optimized short bearing theory is presented, which the authors consider to be a highly efficient analytical framework for the investigation of the dynamic nonlinear behavior of finite journal bearings.

GEARS

(Also see No. 2566)

83-2441

Dynamic Behavior of Straight Bevel Gears of Gleason Type

S. Oda, T. Koide, and Y. Okamura

Faculty of Engrg., Tottori Univ., 4-101 Minami, Koyama-cho, Tottori, Japan, Bull. JSME, 26 (216), pp 1072-1079 (June 1983) 18 figs, 1 table, 9 refs

Key Words: Gears, Bevel gears, Vibration measurement, Noise measurement

Dynamic behavior of straight bevel gears of Gleason type was investigated by measuring the dynamic load, circumferential, radial and axial vibration accelerations of gears and noise under different running conditions.

FASTENERS

83-2442

Generation of Elastic Stress Waves at a T-Junction of Square Rods

K.H. Yong and K.J. Atkins

Gang-Nail Australia Limited, Singapore, J. Sound Vib., 88 (4), pp 431-436 (June 22, 1983) 6 figs, 8 refs

Key Words: Joints (junctions), T-beams, Rods, Impact response, Elastic waves, Wave reflection, Wave transmission

Fourier techniques have been used to predict transmitted and reflected waves at a T-joint in rods of square cross-section for an arbitrary longitudinal impulse approaching the joint in the terminating rod. Elementary and Timoshenko beam theory were used for longitudinal and flexural wave motions respectively. Good agreement is obtained between the predicted and experimental results for an input pulse with large wavelengths compared with the lateral dimensions of the rod.

83-2443

Reliability-Based Progressive Fatigue Collapse

S.G. Martindale and P.H. Wirsching

Gulf Oil Exploration and Production Co., Houston

Tech. Ctr., Offshore Tech. Dept., P.O. Box 36506, Houston, TX 77236, ASCE J. Struc. Engrg., 109 (8), pp 1792-1811 (Aug 1983) 6 figs, 4 tables, 14 refs

Key Words: Joints (junctions), Off-shore structures, Drilling platforms, Fatigue life

General relationships between individual joint reliability and overall system reliability in a redundant structure with no repair program are presented. Using a fatigue reliability model, a Monte Carlo analysis provided a distribution of time to failure for various degrees of redundancy. Random variables in the model account for uncertainty in the process of determining fatigue strengths of the joints.

83-2444

Fatigue Behavior of Automatically Welded Beams of Large Dimension and Great Thickness (First Series of Tests) (Comportement al la Fatigue de Pourtres de Grandes Dimensions et de Fortes Epaisseurs Soudees Automatiquement (Premiere Serie d'Essais))

J. Dhuart and E. Piraprez

Liege Univ., Belgium, Rept. No. CRIF-MT-150, 35 pp (Nov 1982)

N83-22644

(In French)

Key Words: Welded joints, Fatigue life

Four large welded joints with very thick plates were subjected to fatigue tests to determine if the welding mode (manual or automatic) and the type of bead (angled or in K) influence their behavior in actual construction.

LINKAGES

83-2445

Analysis on Dynamic Characteristics of Hydraulic Linkage System on Tractor

Zhu Jin Shan and Jin Zhong Hao

Trans. of Chinese Soc. of Agri. Mach. (4), pp 14-26 (1982)

CSTA 631.3-82.11

Key Words: Linkages, Hydraulic systems, Tractors, Damping effects

This paper presents formulae for hydraulic system transfer functions on the basis of a mathematical model of automatic draft control systems that have been used on a tractor. Factors that affect velocity $V(t)$ and displacement $y(t)$ of piston rod are analyzed in terms of control theory. The dynamic characteristics of a hydraulic linkage system is studied with response as a function of time.

VALVES

(Also see No. 2484)

83-2446

Modeling of a Spring-Loaded Safety Valve

A. Singh, D. Shak, and S. Levy

EPRI, Palo Alto, CA, ASME Paper No. 83-NE-21

Key Words: Valves, Piping systems, Dynamic response

A one-dimensional model of a spring loaded self-activating safety valve has been developed to predict its dynamic behavior under steam discharge conditions. The model can be used in conjunction with appropriate piping models to analyze the dynamic behavior of a coupled safety valve-piping system.

83-2447

An Analytical Model of a Spring-Loaded Safety Valve

M.A. Langerman

Intermountain Technologies, Inc., Idaho Falls, ID, ASME Paper No. 83-NE-19

Key Words: Valves, Shock response, Computer programs

This paper presents a discussion of a safety valve model used in conjunction with the Relap5/MOD1 code to calculate the response of a PWR pressurizer safety valve during a saturated steam discharge transient and a water seal discharge transient.

83-2448

The Application of Dynamic Structural Analysis to the EPRI/CE Safety Valve Test Data

E.A. Siegel and S.C. Austin

Combustion Engrg., Inc., Windsor, CT, ASME Paper No. 83-NE-17

Key Words: Valves

Techniques for the application of dynamic analysis for determination of optimum discharge piping support locations and stiffness requirements are presented. Consideration of the effects of linear and gapped supports is also described.

SEALS

83-2449

Finite-Length Solutions for Rotordynamic Coefficients of Turbulent Annular Seals

D.W. Childs

Mech. Engrg. Dept., Texas A&M Univ., College Station, TX 77843, J. Lubric. Tech., Trans. ASME, 105 (3), pp 437-445 (July 1983) 2 figs, 2 tables, 10 refs

Key Words: Seals, Centrifugal pumps, Pumps

Expressions are derived which define dynamic coefficients for high-pressure annular seals typical of wear-ring and interstage seals employed in multistage centrifugal pumps. Completely developed turbulent flow is assumed in both the circumferential and axial directions, and is modeled by Hirs' turbulent lubrication equations. Linear zeroth and first-order perturbation equations are developed by an expansion in the eccentricity ratio. The influence of inlet swirl is accounted for in the development of the circumferential flow. The zeroth-order momentum and continuity equations are solved exactly, while their first-order counterparts are reduced to three ordinary, complex, differential equations in the axial coordinate Z. The equations are integrated to satisfy the boundary conditions and define the pressure distribution due to seal motion. Integration of the pressure distribution defines the reaction force developed by the seal and the corresponding dynamic coefficients. Finite-length solutions for the coefficients are compared to two short-seal solutions.

83-2450

Dynamic Analysis of Turbulent Annular Seals Based on Hirs' Lubrication Equation

D.W. Childs

Mech. Engrg. Dept., Texas A&M Univ., College Station, TX 77843, J. Lubric. Tech., Trans. ASME, 105 (3), pp 429-436 (July 1983) 5 figs, 14 refs

Key Words: Seals, Centrifugal pumps, Pumps, Stiffness coefficients, Damping coefficients

Expressions are derived which define dynamic coefficients for high-pressure annular seals typical of neck-ring and interstage seals employed in multistage centrifugal pumps. Completely developed turbulent flow is assumed in both the circumferential and axial directions, and is modeled in this analysis by Hirs' turbulent lubrication equations. Linear zeroth and first-order "short-bearing" perturbation solutions are developed by an expansion in the eccentricity ratio. The influence of inlet swirl is accounted for in the development of the circumferential flow field. Comparisons are made between the stiffness, damping, and inertia coefficients derived herein based on Hirs' model and previously published results based on other models. Numerical results are presented for interstage seals in the Space Shuttle main engine high pressure fuel turbopump and a water pump.

STRUCTURAL COMPONENTS

BARS AND RODS

83-2451

Anchorage of Reinforcing Bars for Reversed Cyclic Loading

I.-J. Lin and N. Hawkins

Dept. of Civil Engrg., Univ. of Washington, Seattle, WA, Rept. No. SM82-1, NSF/CEE-82102, 189 pp (June 1982)

PB83-204875

Key Words: Bars, Stiffeners, Cyclic loading, Seismic excitation

An analytical model is developed that predicts the load-slip characteristics of reinforcing bars anchored within exterior beam-column joints in reinforced concrete structures subject to earthquake loading. The model is developed from knowledge of fundamental mechanical characteristics for the reinforcing bar, for the interface between that bar and the surrounding concrete, and from the requirements for continuity of forces and displacements along the anchorage length for the bar. The analytical results predicted by the model are compared to experimental results for 22 specimens.

BEAMS

(Also see Nos. 2411, 2422, 2432, 2442)

83-2452

Contribution to Solving the Dynamics of Timoshenko Beam

P. Horyl

Technical Univ. of Mining and Metallurgy of Ostrava, Czechoslovakia, Strojnický Časopis, 34 (3), pp 313-324 (1983) 3 figs, 3 tables, 8 refs

(In Czech)

Key Words: Beams, Timoshenko theory, Finite element technique

This paper deals with the computation of eigenvalues of undamped linear vibration of a Timoshenko beam using the deformation variant of the finite element method. Shape functions are chosen on the basis of the mathematical solution of differential equations of vibration according to T.C. Huang. Computed results are compared with data given in references.

CYLINDERS

(Also see No. 2488)

83-2453

Eigenvalue Approach to the Longitudinal Vibration of a Circular Cylinder Coupled with a Thermal Field

N.D. Das, S.K. Bhattacharya, and S.N. Das

Dept. of Mathematics, Jadavpur Univ., Calcutta - 700 032, India, Mech. Res. Comm., 10 (3), pp 133-142 (1983) 1 fig, 14 refs

Key Words: Cylinders, Circular cylinders, Longitudinal vibration, Eigenvalue problems

The equations governing the longitudinal vibration of a circular cylinder coupled with a thermal field are presented in the form of a matrix differential equation and solved by means of algebraic eigenvalue approach. The results are compared with those appearing in the existing literature.

COLUMNS

(Also see No. 2402)

83-2454

Dynamic Stability of a Kelvin-Viscoelastic Column

G. Ahmadi and P.G. Glockner

Dept. of Mech. and Industrial Engrg., Clarkson College, Potsdam, NY, ASCE J. Engrg. Mech., 109 (4), pp 990-999 (Aug 1983) 2 figs, 34 refs

Key Words: Columns, Viscoelastic properties, Dynamic stability, Time dependent parameters, Random excitation

Dynamic stability of a Kelvin-viscoelastic column subjected to a time varying axial load is considered. Deterministic loads with sinusoidal time variation is studied which reduces to a Mathieu equation. Special attention is given to stationary random excitations. Sufficiency stability criteria for columns subjected to white noise, Gaussian and general stationary random loadings are established.

83-2455

The Experimental Investigation of the Seismic Resistance Behaviour of Reinforced Concrete Hollow Core Columns

Shen Ju Min, et al

J. Bldg. Structure, 3 (5), pp 21-30 (1982)

CSTA 624-82.72

Key Words: Columns, Concretes, Reinforced concrete, Seismic response

The behavior of reinforced concrete hollow core columns under cyclic loading is discussed. The influences of the percentage of hollow core, the ratio between axial forces and compression strength of concrete as well as the arrangement of stirrups and longitudinal reinforcement on the hysteretic characteristics and ductility of hollow core columns are investigated and compared with that of solid columns.

83-2456

Free Bending Vibration of Circular Column Partially Submerged in Water

Zhang Xi De

Appl. Math. and Mechanics, 3 (4), pp 581-590 (1982)

CSTA 531-82.122

Key Words: Columns, Submerged structures, Flexural vibration

The bending vibration of a circular column partially submerged in water is studied. An equation of frequency and an exact solution of corresponding function of vibrational modes are given.

83-2457

Vibration and Stability of Elastic Columns Subjected to Triangularly Distributed Sub-Tangential Forces

Y. Sugiyama and K.A. Mladenov

Dept. of Mech. Engrg., Tottori Univ., Koyama, Tottori, Japan, J. Sound Vib., 88 (4), pp 447-457 (June 22, 1983) 7 figs, 1 table, 13 refs

Key Words: Columns, Dynamic stability, Flutter

The dynamic behavior of elastic columns under the action of triangularly distributed subtangential forces is investigated to fill the gap between the classical conservative and typical nonconservative cases. The stability maps which are obtained from the eigenvalue analysis determine the divergence and flutter domains.

FRAMES AND ARCHES

83-2458

Seismic Analysis of High-Density Spent Fuel Storage Racks

G.A. Harstead, N.F. Morris, and A.I. Unsal

Harstead Engrg. Assoc. Inc., Park Ridge, NJ, ASME Paper No. 83-NE-11

Key Words: Racks, Storage tanks, Seismic analysis

A proposed procedure for the seismic analysis of fuel storage racks is presented. Its application to free-standing fuel racks demonstrates that such racks can be expected to be affected less by seismic loading than fixed-base fuel racks.

83-2459

Seismic Response of Free-Standing Fuel Rack Construction to 3-D Floor Motion

A.I. Soler and K.P. Singh

Univ. of Pennsylvania, Philadelphia, PA, ASME Paper No. 83-NE-10

Key Words: Racks, Storage tanks, Seismic analysis

The method of analysis is used to compare the seismic response of some representative rack designs. Results show wide differences in the structural response, depending on the fabrication details of racks.

83-2460

Optimal Seismic-Resistant Design of a Planar Steel Frame

R.J. Balling, K.S. Pister, and V. Ciampi

Dept. of Civil Engrg., Brigham Young Univ., Provo, UT 84602, Intl. J. Earthquake Engrg. Struc. Dynam., 11 (4), pp 541-556 (July/Aug 1983) 7 figs, 1 table, 21 refs

Key Words: Frames, Steel, Seismic design, Buildings, Multistory buildings

This paper illustrates the design of a four-story, three-bay, moment-resisting, planar steel frame. Nonlinear step-by-step integration is used as the analysis technique within the design process itself rather than as a check at the end of the design process. A sophisticated optimization algorithm is utilized to solve the resulting mathematical programming problem. Comparative results concerning the computational phase as well as performance of both preliminary and final designs are presented. The practicality and reliability of the design method are assessed.

MEMBRANES, FILMS, AND WEBS

83-2461

Multimode Response of a Circular Membrane

K. Yasuda and H. Uno

Nagoya Univ., Chikusaku, Nagoya, Japan, Bull. JSME, 26 (216), pp 1050-1058 (June 1983) 10 figs, 7 refs

Key Words: Membranes (structural members), Circular membranes, Harmonic excitation

The nonlinear axisymmetric dynamic response of a circular membrane to harmonic excitation near one of the primary resonance points will differ qualitatively from the usual harmonic response, because the corresponding linearized natural frequencies are in an approximate arithmetical progression. Theoretical analyses are conducted of the responses near the first three primary resonance points. Experimental analyses are also conducted near the second primary resonance points. The experimental results confirm the validity of the theoretical analyses.

83-2462

Analysis of Vibrational Resonances in High Mesh Nets by an Optical Method

E. Furman and Y. Finkelshtein

Armament Development Authority, P.O. Box 2250, Haifa, Israel, J. Sound Vib., 88 (4), pp 501-505 (June 22, 1983) 3 figs, 2 tables, 2 refs

Key Words: Grids (beam grids), Vibration measurement, Resonant frequencies, Optical methods

Experimental analysis of resonances in a vibrating net is presented. The net functions as a diffraction grating and its vibration modulates the diffraction pattern in time and space. This modulation, when recorded, carries information about vibrational parameters such as resonant frequencies. The measured frequencies are compared with those predicted by theory.

PANELS

83-2463

Transmission Loss of Damped Asymmetric Sandwich Panels with Orthotropic Cores

C.L. Dym and D.C. Lang

Dept. of Civil Engrg., Univ. of Massachusetts, Amherst, MA 01003, J. Sound Vib., 88 (3), pp 299-319 (June 8, 1983) 15 figs, 4 tables, 15 refs

Key Words: Panels, Sandwich structures, Damped structures, Core-containing structures

A theoretical model of the acoustic performance of asymmetric sandwich panels is developed and verified by comparison with experimental data. The panel models consist of unequal elastic isotropic skins sandwiching an elastic orthotropic core. Damping is incorporated in both the skins and the core. The roles of various structural and material properties are determined via a parametric study. The importance of phase wave speeds and panel impedances for physically symmetric panels is discussed, as are implications for transmission loss characterization.

PLATES

(Also see No. 2432)

83-2464

Inertia Effects on the Dynamics of a Disk Levitated by Incompressible Laminar Fluid Flow

D.K. Warinner and J.T. Pearson

Argonne Natl. Lab., Argonne, IL 60439, J. Engrg. Power, Trans. ASME, 105 (3), pp 643-653 (July 1983) 15 figs, 2 tables, 41 refs

Key Words: Disks (shapes), Squeeze film dampers, Inertial forces

This paper develops a nonlinear ordinary differential equation (ODE) of motion for a disk parallel to a flat plate and levitated by incompressible laminar flow of fluid supplied from a central orifice. The fluid's inertia, reflected in high mass flow rates, is accounted for. The transient flow velocity and pressure field are found by iterative integration of the Navier-Stokes equation to determine the ODE for the time-dependent height of the disk (or fluid film thickness). The film thickness is found by not only numerically integrating the ODE, but also by linearizing the equation to obtain a closed-form solution.

83-2465

Free-Wave Propagation in an Irregularly Stiffened, Fluid-Loaded Plate

G.P. Eatwell

School of Mathematics, Univ. of Bath, Claverton Down, Bath BA2 7AY, UK, J. Sound Vib., 88 (4), pp 507-522 (June 22, 1983) 9 figs, 12 refs

Key Words: Plates, Fluid-induced excitation, Stiffened plates, Periodic structures

Techniques developed for analysis of the dynamic behavior of random, composite media are applied to the study of free waves in irregularly stiffened plates, with or without fluid-loading. It is well known that the free wave in an exactly periodic structure is a Floquet wave which possesses a structure of pass- and stop-bands. A method is presented for studying a structure in which the exact positions of the stiffening ribs are subject to some degree of randomness. The dispersion relation for free waves in the plate is derived, some solutions are presented and compared with corresponding solutions for the exactly periodic structure.

83-2466

Experimental Study of the Free Vibration of Clamped Trapezoidal Plates

K. Maruyama, O. Ichinomiya, and Y. Narita

Hokkaido Inst. of Tech., 419-2, Teine-Maeda, Nishi-ku, Sapporo, 061-24, Japan, J. Sound Vib., 88 (4), pp 523-534 (June 22, 1983) 6 figs, 2 tables, 9 refs

Key Words: Plates, Trapezoidal bodies, Natural frequencies, Mode shapes, Real time technique, Holographic techniques, Interferometric techniques

The real time technique of time averaged holographic interferometry has been applied to determine the natural frequencies and the corresponding mode shapes for the transverse vibrations of clamped trapezoidal plates. Two kinds of trapezoidal plates have been examined, symmetrical and unsymmetrical. The natural frequencies obtained experimentally have been expressed in terms of a dimensionless frequency parameter, and the results are shown graphically as a function of the ratio of the lengths of the two parallel sides, top and base, of each trapezoid. The experimental results are also compared with analytical ones, and are in satisfactory agreement. In addition, the experimental values of the frequency parameter for each type are tabulated in the Appendix at the end of the paper.

83-2467

Thick-Plate-Equivalent Solution of Dynamic Analysis for Space Structure in High-Rise Buildings

Cao Zhi Yuan

China Civ. Engrg. J., 15 (4), pp 43-52 (1982)
CSTA 624-82.39

Key Words: Plates, Buildings, Multistory buildings, Flexural vibration, Seismic analysis, Wind-induced excitation, Shock excitation

Space frame or frame-shear wall structures in high-rise buildings are treated in this paper as equivalent orthotropic continuous plates, their dynamic analysis is made by use of thick plate theory. Analytical formulae for the first nine order of frequencies and corresponding modes of the transverse vibration and the dynamic calculations of the structures under various live loads (earthquake, wind, shock wave, etc.) are given together with relevant data tables.

83-2468

Analysis of a Plane Inclined Guide Bearing under Transverse Vibration and Translation of a Plate

Y.D. Murray and C.D. Mote, Jr.

Dept. of Mech. Engrg., Univ. of California, Berkeley, CA 94720, J. Lubric. Tech., Trans. ASME, 105 (3), pp 335-341 (July 1983) 6 figs, 3 tables, 17 refs

Key Words: Plates, Flexural vibration, Translational response

Analysis of the load capacity, friction force, and lubricant flow of an infinite width, plane guide during transverse vibration and translation of a plate is presented. The effect of lubricant inertia on these variables is investigated and found to be significant. Analysis is facilitated through assumption of a parabolic velocity distribution across the film thickness as suggested by lubrication theory. The parabolic profile assumption is found to underestimate the contribution of lubricant inertia to the load capacity during plate vibration.

83-2469

Radiation Efficiency of a Baffled Circular Plate in Flexural Vibration

Y. Honda, H. Matsuhisa, and S. Sato

Dept. of Precision Mechanics, Kyoto Univ., Kyoto 606, Japan, J. Sound Vib., 88 (4), pp 437-446 (June 22, 1983) 4 figs, 9 refs

Key Words: Plates, Circular plates, Flexural vibration, Mindlin theory

The radiation efficiency of an edge-clamped circular plate, which is vibrating flexurally in one of its natural modes and is mounted in an infinite baffle, is theoretically determined from the total power radiated to the far field. The vibrations of the plate are investigated both by the classical plate theory and by the improved plate theory (Mindlin plate theory). Approximation formulae for the low frequency region are derived, and curves covering the entire frequency range for the first fifteen modes are obtained through numerical calculation.

83-2470

Vibration of a Solid Rectangular Plate on an Eccentric Annular Elastic Support

K. Nagaya

Dept. of Mech. Engrg., Gunma Univ., Kiryu, Gunma 376, Japan, J. Sound Vib., 88 (4), pp 535-545 (June 22, 1983) 2 figs, 6 tables, 17 refs

Key Words: Plates, Rectangular plates, Elastic foundations, Flexural vibration

The free transverse vibrations of a solid rectangular plate on an eccentric annular elastic support are discussed. In the analysis the reaction force of the inner annular support is assumed to be an unknown external force. The exact solution of the equation of motion which includes terms representing the reaction force of the support is applied. The condition of continuity between the inner annular support and the plate is satisfied exactly. The boundary

conditions of the outer edge of the plate are satisfied directly by making use of the Fourier expansion collocation method.

83-2471

A Comparison of Plate Perforation Models in the Sub-Ordnance Impact Velocity Range

P.J. Shadbolt, R.S.J. Corran, and C. Ruiz
Dept. of Engrg. Science, Oxford Univ., Parks Rd., Oxford OX1 3PJ, UK, Intl. J. Impact Engrg., 1 (1), pp 23-49 (1983) 14 figs, 1 table, 19 refs

Key Words: Plates, Perforation, Projectile penetration, Penetration, Impact force

Plate perforation in the sub-ordnance velocity range is accompanied by substantial plate deflections away from the impacting projectile. Any theoretical treatment has to consider the dynamic plate deflections in conjunction with a failure criterion for perforation. Two approaches are presented: the first applies a method used previously on beams and the second is a new approach for plate impact which uses an approximate upper bound solution of the dynamic plate equilibrium equations. Comparison is made with experimental results for three materials – mild steel, stainless steel, and aluminium.

83-2472

Impact Loading of Plates – An Experimental Investigation

R.S.J. Corran, P.J. Shadbolt, and C. Ruiz
Dept. of Engrg. Science, Oxford Univ., Parks Rd., Oxford OX1 3PJ, UK, Intl. J. Impact Engrg., 1 (1), pp 3-22 (1983) 15 figs, 1 table, 14 refs

Key Words: Plates, Projectile penetration, Penetration, Impact force, Experimental test data

The impact of projectiles at sub-ordnance velocities against mild steel, stainless steel, and aluminium plates has been studied in a series of experiments. The projectile mass, nose shape, and hardness have been shown to have an important effect on penetration as does the target rigidity and support condition. All materials exhibit a clear kink effect related to a change from energy absorption by plastic deformation to perforation with well-defined shear bands and no appreciable bulging.

SHELLS

83-2473

Dynamic Buckling of Elastic-Plastic Complete Spherical Shells under Step Loading

B. Song and N. Jones
Dept. of Mech. Engrg., The Univ. of Liverpool, P.O. Box 147, Liverpool L69 3BX, UK, Intl. J. Impact Engrg., 1 (1), pp 51-71 (1983) 7 figs, 2 tables, 26 refs

Key Words: Shells, Spherical shells, Step response, Dynamic buckling

The dynamic axisymmetrical behavior of a perfect complete spherical shell made from a bilinear or work hardening material and subjected to a uniform external step pressure loading is investigated. A perturbation method of analysis leads to a Mathieu equation which gives the dynamic buckling pressure and associated mode for a complete spherical shell. The influence of the plastic parameter and damping on the dynamic buckling pressure and mode number are also discussed.

83-2474

Vibrations of Noncircular Cylindrical Shells

K. Suzuki, S. Tamura, T. Kosawada, and S. Takahashi
Faculty of Engrg., Yamagata Univ., Yonezawa, Japan, Bull. JSME, 26 (215), pp 818-826 (May 1983) 9 figs, 9 refs

Key Words: Shells, Cylindrical shells, Free vibration, Natural frequencies, Mode shapes

A method is presented for analyzing free vibrations of thin cylindrical shells with noncircular cross sections which have been used in chemical plants, atomic plants, flight structures, etc. This method is a general one applicable to various noncircular cylindrical shells. An exact solution of a noncircular cylindrical shell with freely supported ends is obtained. By numerical calculations natural frequencies and mode shapes of elliptical cylindrical shells are also obtained and their characteristics are clarified.

83-2475

Non-Linear Dynamic Analysis of Shallow Spherical Shells on Elastic Foundations

Y. Nath and R.K. Jain

Applied Mechanics Dept., Indian Inst. of Tech., Hauz Khas, New Delhi 110016, India, Intl. J. Mech. Sci., 25 (6), pp 409-419 (1983) 9 figs, 1 table, 20 refs

Key Words: Shells, Spherical shells, Elastic foundations

The effect of Winkler-Pasternak elastic foundation parameters on the nonlinear dynamic response of shallow spherical shells is investigated. The values of foundation parameters (K and G) are determined for the minimaximum central response of the shallow shells for both the clamped as well as simply supported immovable edge conditions. Donnell type partial differential equations governing the moderately large amplitude behavior of shallow spherical shells resting on Winkler-Pasternak elastic foundations under step pressure loading are analyzed. The space and time-wise integrations of governing equations are carried out using Chebyshev series and Houbolt techniques.

83-2476

Analysis of Reinforced Concrete Containment Vessels with Nonlinear Shearing Stiffness

C.H. Conley, R.N. White, and P. Gergely

Dept. of Structural Engrg., Cornell Univ., Ithaca, NY, 112 pp (Apr 1983)

NUREG/CR-3255

Key Words: Shells, Reinforced concrete, Containment structures, Internal pressure, Seismic excitation, Finite element technique

This report summarizes the development of a 3-D nonlinear finite element analytical capability of reinforced concrete shell structures, and gives the results of a series of analyses of cylindrical containment vessels subjected to internal pressure and idealized seismic forces.

PIPES AND TUBES

(Also see No. 2540)

83-2477

Criteria for Evaluating Steady-State Piping Vibrations of Nuclear Power Piping

R.C. Sampson

Bechtel Power Corp., San Francisco, CA, ASME Paper No. 83-PVP-11

Key Words: Piping systems, Nuclear power plants, Periodic response

Parameters influencing pipe stress as a result of normal vibration modes are reviewed. A simplified analytical model for upper bounds criteria on pipe stress is developed.

83-2478

Dynamic Decoupling of Small Branch Piping Subsystems

Z.N. Ibrahim and M.O. Callahan

Sargent & Lundy Engineers, Chicago, IL, ASME Paper No. 83-PVP-42

Key Words: Piping systems, Nuclear reactor components, Nuclear power plants

Nuclear power plant piping systems are subjected to a wide range of anticipated and postulated dynamic excitations. The dynamic analyses performed to assess these piping systems require mathematical modeling of all interconnecting pipes.

83-2479

Experimental Evaluation of the Nonlinear Seismic Response of a Nuclear Piping System with Different Support Conditions

J.C. Stoessel and P. Ibanez

ANCO Engineers, Inc., Culver City, CA, ASME Paper No. 83-PVP-34

Key Words: Piping systems, Nuclear reactor components, Viscoelastic damping, Seismic response, Experimental test data

A series of tests performed on a piping system model subject to high-level seismic excitation has produced much data useful to nonlinear analysis and plastic design techniques. Also tested was the effect of a visco-elastic damper used to reduce seismic effects on piping systems.

83-2480

Inelastic Response of Piping Systems Subjected to In-Structure Seismic Excitation

R.D. Campbell, R.P. Kennedy, and R.D. Thrasher

Structural Mechanics Assoc., Inc., Newport Beach, CA, ASME Paper No. 83-PVP-50

Key Words: Piping systems, Seismic analysis

It is shown that the factor of safety against failure is variable and is dependent upon the frequency content of the loading, the dynamic characteristics of the piping system, and the allowable system ductility. A recommendation is made for revision to current criteria on the basis of maintaining a constant factor of safety for dynamic and static loading.

83-2481

Use of the Modal Superposition Technique for Piping System Blowdown Analysis

A.G. Ware and R.W. Macek

EG&G Idaho, Inc., Idaho Falls, ID, ASME Paper No. 83-PVP-34

Key Words: Piping systems, Seismic response, Modal superposition method

A standard method of solving for the seismic response of piping systems is the modal superposition technique. Only a limited number of structural modes are considered (typically those up to 33 Hz in the U.S.), since the effect on the calculated response due to higher modes is generally small, and the method can result in considerable computer cost savings over the direct integration method.

83-2482

Seismic Testing and Analysis of a Prototypic Nonlinear Piping System

D.A. Barta, M.J. Anderson, and L.K. Severud

Hanford Engrg. Development Lab., Richland, WA, Rept. No. HEDL-SA-2707-FP, CONF-821101-13, 19 pp (Nov 1982) (ASME Winter Annual Mtg., Phoenix, AZ, Nov 14, 1982)
DE83002909

Key Words: Piping systems, Supports, Seismic response, Experimental test data

A series of seismic tests and analyses of a nonlinear fast flux test facility prototypic piping system are described, and measured responses are compared with analytical predictions. The test loop was representative of a typical LMFBR insulated small bore piping system and it was supported from a rigid test frame by prototypic dead weight supports, mechanical snubbers and pipe clamps. Various piping support configurations were tested and analyzed to evaluate the effects of free play and other nonlinear stiffness characteristics on the piping system response.

83-2483

Detonation Waves in Pipes with Variable Cross-Section

I. Teipel

Inst. f. Mechanik, Universität Hannover, D-3000, Hannover, West Germany, Acta Mechanica, 47 (3-4), pp 185-191 (1983) 3 figs, 7 refs

Key Words: Pipes (tubes), Variable cross section, Shock wave propagation

The investigation of detonation waves in a pipe with variable cross-section is carried out using the characteristic rule. The detonation waves are considered as non-adiabatic shock waves. For the case of a spherical flow field of a Chapman-Jouguet detonation one obtains good agreement with the exact solution. The procedure is extended to general variations of the cross-section.

83-2484

Calculation of Safety Valve Discharge Piping Hydrodynamic Loads Using Relaps/MOD1

R.K. House, M.A. Langerman, D.L. Caraher, and G.A. Cordes

Intermountain Technologies, Inc., Idaho Falls, ID, ASME Paper No. 83-NE-18

Key Words: Piping systems, Valves, Shock response, Computer programs

This paper illustrates the use of the Relaps/MOD1 thermal-hydraulic code for calculating the fluid response in valve discharge piping. Emphasis is placed on calculation of hydrodynamic forcing functions.

83-2485

A Numerical Approach for Flow-Induced Vibration of Pipe Structures

E.C. Ting and A. Hosseinipour

School of Civil Engrg., Purdue Univ., West Lafayette, IN 47907, J. Sound Vib., 88 (3), pp 289-298 (June 8, 1983) 6 figs, 14 refs

Key Words: Piping systems, Fluid-induced excitation, Numerical methods, Transient response

A structural impedance approach is extended for the dynamic analysis of pipe structures conveying fluid flow. The method is efficient in computation and convenient for studying transient responses. Thus, it is possible to study the transition from a stable condition to an unstable condition of the pipe structure as the flow speed increases. The structure may also exhibit different modes of instability. The present approach predicts the mode without prior assumption. Numerical examples are given for a hanging cantilever and a simply supported pipe. The critical speed associated with the dynamic stability is calculated and compared with available analytical and experimental results.

83-2486

DOE/ANL/HTRI Heat-Exchanger-Tube Vibration Data Bank

H. Halle, J.M. Chenoweth, and M.W. Wambsganss
Argonne Natl. Lab., Argonne, IL, Rept. No. ANL-CT-80-3-Add.3, 49 pp (Jan 1983)
DE83008726

Key Words: Heat exchangers, Tube arrays, Fluid-induced excitation, Data processing

The heat exchanger tube vibration data bank was established to accumulate comprehensive case histories on heat exchangers that have experienced tube vibration problems and on units that have been trouble free, and to render this information available for evaluation, improvement, and development of vibration prediction methods and design guidelines. Nine new case histories are presented.

83-2487

Correlation of Support Impact Force and Fretting-Wear for a Heat Exchanger Tube

P.L. Ko and H. Basista
Atomic Energy of Canada Ltd., Chalk River, Ontario, Canada, ASME Paper No. 83-PVP-62

Key Words: Tube arrays, Heat exchangers, Wear, Fretting corrosion, Supports

The correlation between the experimental wear results and different force functions is shown. A computer code for calculating tube/tube support dynamic interaction is used in conjunction with the correlation curve to predict tube wear rates that are then compared to those measured. A brief review of wear mechanisms observed by others is included to provide a background for the development of the force function.

83-2488

Instability Mechanisms and Stability Criteria of a Group of Circular Cylinders Subjected to Cross-Flow Part 2: Numerical Results and Discussions

S.S. Chen
Components Technology Div., Argonne Natl. Lab., Argonne, IL 60439, J. Vib. Acoust. Stress Rel. Des., Trans. ASME, 105 (2), pp 162-260 (Apr 1983) 9 figs, 1 table, 25 refs

Key Words: Cylinders, Tube arrays, Fluid-induced excitation

The fluid-force coefficients for a row of cylinders and a square array are determined from available experimental data and critical flow velocities are calculated as a function of system parameters. Experimental data for critical flow velocities are found to be in good agreement with the analytical results. It is concluded that different stability criteria have to be utilized in different parameter ranges because of different instability mechanisms.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

(Also see No. 2407)

83-2489

On the Prediction of Impact Noise, V: The Noise from Drop Hammers

E.J. Richards, I. Carr, and M. Westcott
Inst. of Sound and Vib. Res., Univ. of Southampton, Southampton S09 5NH, UK, J. Sound Vib., 88 (3), pp 333-367 (June 8, 1983) 27 figs, 3 tables, 12 refs

Key Words: Noise prediction, Impact noise, Hammers

In earlier papers in this series, the concepts of acceleration and ringing noise have been studied in relation to impact

machines, and values of radiation efficiency have been obtained for the various types of structural components. In the work reported in this paper the predicted and measured noise radiation from a drop hammer, both in full-scale and in 1/3-scale model form, were examined.

83-2490

Acceleration Noise Generated by a Random Repeated Impact Process

L.A. Wood and K.P. Byrne
Engrg. Dept., General Motors -- Holden's Limited, Port Melbourne, Victoria 3207, Australia, J. Sound Vib., 88 (4), pp 489-499 (June 22, 1983) 7 figs, 1 table, 5 refs

Key Words: Noise generation, Impact noise

Acceleration noise levels generated by a random repeated impact process are predicted and compared with experimental measurements. The process consists of a ball bouncing on a randomly vibrating surface, and is an idealized representation of random impact phenomena which can occur in machinery and transportation systems where a rolling element is in intermittent contact with the rolling surface. Predictions of the magnitudes of impacts and the times between them are used in conjunction with established acoustic theory to estimate acceleration noise levels generated by the impacting ball.

83-2491

Loudness of Tone Complexes as a Function of the Band-width, the Sound Pressure Level and the Added Broadband Noise (Lautstärke von Tonkomplexen in Abhängigkeit von der Bandbreite, vom Schallpegel und von zugefügtem Breitbandrauschen)

E. Zwicker and Y. Yamada
Lehrstuhl f. Elektroakustik, Technische Universität Munchen, Fed. Rep. Germany, Acustica, 53 (1), pp 26-30 (May 1983) 4 figs, 1 table, 14 refs
(In German)

Key Words: Sound pressure levels

The loudness level of tone complexes composed of two or eight tones in a frequency range around 1 kHz is measured as a function of the total band-width, the SPL, and the level of an added uniform masking noise by the method of constant stimuli. For constant SPL, the results show constant loudness level for band-widths smaller than the critical band, but increasing loudness level for sounds exceeding critical band-width. For large SPL and partial masking by broadband noise the increment becomes smaller.

83-2492

A Mathematical Model for Evaluation and Prediction of the Mean Energy Level of Traffic Noise in Italian Towns

G.B. Cannelli, K. Gluck, and S. Santoboni
Istituto di Acustica "O.M. Corbino" CNR Via Cassia 1216 Roma, Italia, Acustica, 53 (1), pp 31-36 (May 1983) 5 figs, 1 table, 7 refs

Key Words: Traffic noise, Noise pollution

A mathematical model for evaluating and predicting the mean energy level of traffic noise was made ad hoc for Italian towns. The reliability of the model was tested, on the basis of 220 traffic noise samples, by computing the coefficient of correlation between L_{eq} predictions and measurements. The correlation was very good ($r = 0.96$).

83-2493

Measurements of the Influence of Fittings and Roof Pitch on the Sound Field in Panel-Roof Factories

M. Hodgson
Dept. of Architecture, Univ. of Cambridge, Cambridge, UK, Appl. Acoust., 16 (5), pp 369-391 (1983) 14 figs, 12 refs

Key Words: Industrial facilities, Noise generation, Noise reduction, Roofs

Measurements are presented of the sound absorption of two factory machines. Their third octave absorption, between 160 Hz and 5 kHz, is in the range 0·5 - 2·6m^2. Measurements of reverberation time (RT) and/or sound propagation (SP) in four factories with panel roofs, when empty and/or fitted, are also presented. The general characteristics of RT and SP in such factories, and the factors that influence them, are discussed.

83-2494

The Application of Barriers, Enclosures and Area Absorption to Wire Stranding Operations

J.F. Yerges and J.G. Bollinger

Yerges Consulting Engineers, Box 71, Waunakee, WI 53597, Noise Control Engrg., 21 (1), pp 10-20 (July/Aug 1983) 7 figs, 2 tables, 10 refs

Key Words: Industrial facilities, Noise generation, Noise barriers, Enclosures

Wire rope mills are an extreme case of a common type of industrial noise problem. Large numbers of production machines are grouped in regular arrays across the plant floor, producing noise levels in excess of 100 dB(A). A study was undertaken dealing with the application of conventional, or traditional, noise control methods to wire stranding operations. These methods include area absorption, partial-height barriers, and partial and complete enclosures.

83-2495

Noise Characteristics of Large Wind Turbine Generators

H.H. Hubbard, F.W. Grosveld, and K.P. Shepherd
The College of William and Mary, Virginia Associated Res. Campus, 12070 Jefferson Ave., Newport News, VA 23606, Noise Control Engrg., 21 (1), pp 21-29 (July/Aug 1983) 13 figs, 28 refs

Key Words: Wind turbines, Noise generation, Noise source identification

The noise characteristics of three representative large wind turbine generators is summarized. The main noise sources are identified along with state of the art noise prediction methods.

83-2496

Reduction of Noise Generated by Foundry Machinery (Geräuschentwicklung an Formmaschinen in Giessereien wirksam mindern)

U. Eckert and H. Hulshorst
Staatliches Gewerbeaufsichtsamt f. den Regierungsbezirk Detmold, Maschinenmarkt, 88 (82), pp 1669-1672 (1982) 10 figs, 3 refs
(In German)

Key Words: Noise reduction, Machinery noise, Pneumatic equipment

Noise reduction procedures in sand mold producing machinery are discussed. They consist mainly in modification of sand compacting methods. Instead of moving the molding box in order to start the motion of the mold and the sand during precompaction, using the new procedure the sand is moved at high velocities over the stationary mold. Several machines are described which vary mainly in how the sand is accelerated and the way the accelerating air is removed.

83-2497

Generation and Control of Noise in Water Supply Installations: Part 1: Fundamental Aspects

H.F. Fuchs
Fraunhofer-Institut f. Bauphysik, 7000 Stuttgart 80, West Germany, Appl. Acoust., 16 (5), pp 325-346 (1983) 16 figs, 12 refs

Key Words: Hydraulic systems, Noise measurement, Standards and codes

This paper is aimed at improving our understanding of, and communication about, problems of noise in water supply installations. A discussion of the relevant noise measuring standards,their usefulness, applicability and shortcomings is presented. The importance of measuring waterborne sound emission is stressed and a simplified test procedure is recommended.

83-2498

Mechanical Eigenfrequencies of Axisymmetric Fluid Objects: Acoustic Spectroscopy

D. Brill, G.C. Gaunaurd, and H. Uberall
David Taylor Naval Ship Res. & Dev. Ctr., Annapolis, MD 21402, Acustica, 53 (1), pp 11-18 (May 1983) 2 figs, 1 table, 26 refs

Key Words: Natural frequencies, Underwater structures, Elastic waves, Acoustic detection

Echoes of acoustic waves reflected from elastic targets carry within them certain resonance features caused by excitation of the eigenvibrations of the target. By means of a suitable background subtraction it is possible to isolate the target's spectrum of resonances. Extracting resonance information from the echo allows the possibility of identifying the target as to its size, shape, and composition. This is illustrated here by studying the dependence of the resonance spectra of fluid targets in vacuo upon changes of target shape.

SHOCK EXCITATION

(Also see No. 2483)

83-2499

Seismic Evaluation of Electrical Raceway Systems

F. Elsabee, S. Anagnostic, and W. Djordjevic

URS/John A. Blume & Assoc., Danvers, MA, ASME Paper No. 83-PVP-18

Key Words: Electric raceways, Seismic response

The behavior of raceway system components, as determined by testing and analysis, is used as the basis for developing guidelines for modeling various types of raceway systems. The modeling techniques range from simplified representations to detailed models. Procedures for evaluating the responses of the models are established.

83-2500

Suitability of Synthesized Waveforms for Seismic Qualification of Equipment

D.D. Kana and D.J. Pomerening

Southwest Res. Inst., San Antonio, TX, ASME Paper No. 83-PVP-22

Key Words: Equipment response, Seismic response, Accelograms

A set of parameters appropriate for the synthesis of acceleration time histories is developed. The parameters are based on a study of six typical earthquake accelograms, and include general characteristics of the motion, a defintion of strong ground motion, frequency content, stationarity, coherence between orthogonal components, and amplitude probability density.

83-2501

The Spectrum Decomposition Method for Generation of In-Equipment Response Spectra

D.T. Tang

Westinghouse Electric Co., Pittsburgh, PA, ASME Paper No. 83-PVP-19

Key Words: Equipment response, Seismic response

The spectrum decomposition method has been developed for generating the in-equipment response spectra for seismic qualification of electrical equipment assemblies. The method models the floor spectrum-compatible waveform with a collection of uniformly spaced simple waveforms such as sinusoids, sine beats, and decaying sines.

83-2502

Nonlinear Impulsive Force on an Accelerating Container

A.T. Chwang and K.H. Wang

Univ. of Iowa, Iowa City, IA, ASME Paper No. 83-FE-28

Key Words: Hydrodynamic excitation, Impact force

Chwang's nonlinear theory is applied to calculate the impulsive hydrodynamic pressure force on an accelerating rectangular or circular container.

83-2503

Lagrangian Description of Transport Equations for Shock Waves in Three-Dimensional Elastic Solids

Li Yong Chi and T.C.T. Ting

Appl. Math. and Mechanics, 3 (4), pp 491-507 (1982)

CSTA 531-82.113

Key Words: Shock wave propagation

A set of transport equations for the growth or decay of the amplitudes of shock waves along an arbitrary propagation direction in three-dimensional nonlinear elastic solids is derived using the Lagrangian coordinates. The transport equations obtained show that the time derivative of the amplitude of a shock wave along any propagation ray depends on: an unknown quantity immediately behind the shock wave; the two principal curvatures of the shock surface; the gradient taken on the shock surface of the normal shock wave speed; and the inhomogeneous term.

83-2504

The Dynamic Collapse of a Column Impacting a Rigid Surface

J.M. Housner and N.F. Knight, Jr.

NASA Langley Res. Ctr., Hampton, VA, AIAA J., 21 (8), pp 1187-1195 (Aug 1983) 15 figs, 24 refs

Key Words: Impact tests, Columns, Crash research (aircraft)

An analytical investigation is made of the dynamic collapse of an elastic periodically supported column having an attached mass at one end and impacting a rigid surface at the other end with prescribed velocity and angle of incidence. The investigation is carried out using a first-order approximate nonlinear solution and a nonlinear finite element solution.

VIBRATION EXCITATION

83-2505

Method for Improving Incomplete Modal Coupling

R. Bajan, A.R. Kukreti, and C.C. Feng

Systems Management Ctr., Univ. of Southern California, Los Angeles, CA, ASCE J. Engrg. Mech., 109 (4), pp 937-948 (Aug 1983) 6 figs, 1 table, 18 refs

Key Words: Free vibration, Natural frequencies, Mode shapes, Modal coupling

The free vibration of discrete undamped linear dynamic systems commonly designed in structural engineering is studied. A rational method is presented for improving the natural modes and frequencies computed by incomplete modal coupling, without increasing the order of the resultant eigenvalue problem. Improvement is accomplished through use of a candidate table in an iterative process that introduces significant modes into sequential modal analyses.

83-2506

Natural Damped Frequencies of an Infinitely Long Column of Immiscible Viscous Liquids

H.F. Bauer

Hochschule der Bundeswehr, München, Fachbereich Luft- und Raumfahrtechnik, Forsch. Ingenieurwesen, 49 (4), pp 117-126 (1983) 10 figs, 17 refs

Key Words: Natural frequencies, Fluids, Damping

The natural damped frequencies of an infinitely long column consisting of one or two immiscible viscous liquids are determined. The two-dimensional case; i.e., a liquid column exhibiting axial independence, is treated. Resulting analytical expressions for the frequency equations are evaluated numerically.

83-2507

Transonic Time-Response Analysis of 3-Degree-of-Freedom Conventional and Supercritical Airfoils

T.Y. Yang and J.T. Batina

Purdue Univ., West Lafayette, IN, J. Aircraft, 20 (8), pp 703-710 (Aug 1983) 17 figs, 2 tables, 16 refs

Key Words: Airfoils, Flutter, Aerodynamic loads

Aeroelastic time-response analyses are performed for two conventional airfoils, NACA 64A006 and NACA 64A010, and one supercritical airfoil, MBB A-3, in small-disturbance transonic flow. Response results for forces and displacements are obtained by simultaneously integrating the structural equations of motion with the unsteady aerodynamic forces computed using two transonic codes: LTRAN2-NLR and USTS. Three-degrees-of-freedom -- plunge, pitch, and aileron pitch -- are considered.

MECHANICAL PROPERTIES

DAMPING

(Also see Nos. 2359, 2362, 2371, 2418)

83-2508

The Effect of Journal Misalignment on the Oil-Film Forces Generated in a Squeeze Film Damper

R.A. Cookson, X.H. Feng, and S.S. Kossa

School of Mech. Engrg., Cranfield Inst. of Tech., Bedford MK43 0AL, UK, J. Engrg. Power, Trans. ASME, 105 (3), pp 560-563 (July 1983) 5 figs, 8 refs

Key Words: Squeeze film dampers, Shafts, Alignment

In this theoretical study an attempt is made to evaluate the effect of misalignment on the magnitude of the oil-film forces produced in a squeeze film damper bearing, and a computational procedure is established. It is clearly shown that the effect of misalignment in a two-band, squeeze film damper can lead to a significant increase in the transmission of unbalance force through the oil film.

83-2509

Squeeze-Film Damper Technology: Part 1 -- Prediction of Finite Length Damper Performance

J.W. Lund, A.J. Smalley, J.A. Tecza, and J.F. Walton
Univ. of Copenhagen, Denmark, ASME Paper No. 83-GT-247

Key Words: Dampers, Squeeze film dampers, Mathematical models, Computer programs

This paper describes an analysis method and boundary conditions developed recently for modeling dampers, and in particular, covers the treatment of finite length, feed and drain holes, and fluid inertia effects, the latter having been shown recently to be of great importance in predicting rotor system behavior. A computer program that solves the Reynolds equation for the above conditions is described and sample calculation results presented.

83-2510

Squeeze-Film Damper Technology: Part 2 – Experimental Verification Using a Controlled-Orbit Test Rig

J.A. Tecza, J.C. Giordano, E.S. Zorzi, and S.K. Drake
Mechanical Technology, Inc., Latham, NY, ASME Paper No. 83-GT-248

Key Words: Dampers, Squeeze film dampers, Experimental test data

A series of damper tests are described in which a controlled-orbit rig is used to explore squeeze-film damper behavior for representative gas turbine damper geometries and to verify and calibrate the damper analysis program.

83-2511

Damping Estimation Method Using the Spectral Analysis Technique Based on the Auto-Regressive Model Fitting

K. Suzuki and A. Nakashima
Tokyo Metropolitan Univ., 2-1-1, Fukazawa, Setagaya-ku, Tokyo, Japan, Bull. JSME, 26 (215), pp 832-838 (May 1983) 11 figs, 5 tables, 14 refs

Key Words: Damping coefficients, Spectrum analysis, Random vibration, ARMA (autoregressive/moving average) models, Seismic analysis, Ground vibration

A practical method which can estimate the damping ratio of a structure subjected to random excitations is proposed. This method is based on the characteristics of the AR spectral analysis technique by Akaike. Using good correspondence of the shape of the frequency response function around the dominant peaks in the proposed method to that in the linear structural theory, estimation of the damping ratio to the fundamental vibration modes can be satisfactorily carried out using the curve-fitting technique.

83-2512

Fundamental Investigation of an Oil Damper. 2nd Report: Analysis Based on the Unsteady Flow Assumption

H. Sekiguchi and T. Asami
Himeji Inst. of Tech., 2167, Shosha, Himeji, Hyogo, 671-22, Japan, Bull. JSME, 26 (215), pp 856-863 (May 1983) 12 figs, 12 refs

Key Words: Dampers, Oil dampers

This paper deals with the dynamic characteristics of an oil damper whose piston is vibrating axially in a viscous fluid in a fixed circular cylinder. Assuming a one-dimensional flow past the annular cross-sectional clearance between the piston and the cylinder, a drag force acting on the piston is evaluated. Analytical results are compared with experimental observations.

83-2513

Linear Force Coefficients for Squeeze-Film Dampers

A.Z. Szeri, A.A. Raimondi, and A. Giron-Duarte
Univ. of Pittsburgh, Pittsburgh, PA 15261, J. Lubric. Tech., Trans. ASME, 105 (3), pp 326-334 (July 1983) 8 figs, 14 refs

Key Words: Dampers, Squeeze-film dampers

A simplified analysis of viscous squeeze-film damper behavior is presented. It makes use of the notation of averaged inertia and calculates linear velocity and inertia coefficients. These coefficients are shown to be accurate at practical values of the length/diameter ratio and the gap Reynolds number of the viscous damper.

83-2514

The Control of Engine Vibration Using Squeeze Film Dampers

R. Holmes

Univ. of Sussex, School of Engrg. and Appl. Sciences, Falmer, Brighton, Sussex BN1 9QT, UK, J. Engrg. Power, Trans. ASME, 105 (3), pp 525-529 (July 1983) 8 figs, 10 refs

Key Words: Dampers, Squeeze film dampers, Engine vibration, Vibration control

This paper describes the following roles of a squeeze-film damper when used in gas turbine applications as a means of reducing vibration and transmitted force due to unbalance: as an element in parallel with a soft spring in a vibration isolator; and as an element in series with the stiffness of the engine pedestal. The effects of cavitation on performance are elucidated, and the dangers of jump phenomena and sub-synchronous response are discussed. Experimental work is described in which both roles of the squeeze-film damper are investigated and the results are compared with theoretical predictions.

83-2515

A Nonparametric Method of Identification of Vibration Damping in Nonlinear Dynamic Systems

M. Kulisiewicz

Technical Univ. of Wroclaw, Inst. of Material Science and Technical Mechanics, Wroclaw, Poland, Intl. J. Solids Struc., 19 (7), pp 601-609 (1983) 7 figs, 2 tables, 9 refs

Key Words: Vibration damping, Coulomb friction, Viscoelastic damping

An original method for identifying nonlinear dynamic system damping characteristics is presented. The method suggested allows one to precisely estimate both the magnitude of Coulomb friction and viscoelastic damping. Examples of the practical application of the method to mechanics are presented.

83-2516

Operators and Fractional Derivatives for Viscoelastic Constitutive Equations

L. Rogers

Flight Dynamics Lab., AFWAL/FIBA, Wright-Patterson AFB, OH 45433, J. Rheology, 27 (4), pp 351-372 (1983) 7 figs, 22 refs

Key Words: Damping, Constitutive equations, Viscoelastic damping

The operator form of the constitutive equation containing fractional derivatives leads to an expression for the complex modulus which is a ratio of polynomials of fractional order in reduced frequency. A ratio of factored polynomials is developed by use of Bode diagrams; another related form arises from the generalized fractional Maxwell model. Bode diagrams are used to determine parameter values. Interconversion to other mechanical properties is outlined. The results potentially form the basis of a new theory.

83-2517

Experience with Nonuniform Damping in the Seismic Analysis of Nuclear Plant Components

B.V. Winkel and L.J. Julyk

Westinghouse Co., Richland, WA, ASME Paper No. 83-PVP-47

Key Words: Damping, Seismic analysis, Beams, Pipes (tubes), Nuclear reactor components

Various methods of accounting for nonuniform damping in a structural model are reviewed and evaluated. The methods are compared by solving a beam/pipe model subjected to a typical seismic ground motion.

83-2518

Application of Nonconstant Modal Damping Ratio for Response Spectrum Method of Analysis

M.Y. Wu and E.O. Swain

General Electric Co., San Jose, CA, ASME Paper No. 83-PVP-25

Key Words: Modal damping, Spectrum analysis

The application of nonconstant modal damping for response spectrum analysis from the predefined damping response spectra are developed and evaluated. The method of selecting the spectral acceleration according to the nonconstant modal damping not only provides better answers for the response spectrum method of analysis, but may well save hardware changes in the future.

FATIGUE

(Also see Nos. 2443, 2444, 2487)

83-2519

Thermal Fatigue Properties and Failure Characteristics of Materials for Prechamber Nozzle in Combustion Gas

Wang Mo Ning, et al
J. China Railway Soc., 4 (3), pp 76-85 (1982)
CSTA 625.1-82.41

Key Words: Fatigue life, Nozzles, Diesel engines

Selection of materials and investigation of the failure mechanism of prechamber nozzles for high speed diesel engines is studied. Thermal fatigue tests for eight alloys in combustion gas are carried out, results showing that nickel-base fine-grain GH128 alloy has the highest thermal fatigue property.

ELASTICITY AND PLASTICITY

83-2520
The Study of Dynamic Fracture Propagation Using a Special Finite Element Technique
K.W. Chan and F.T.C. Loo
Mech. and Indus. Engrg. Dept., Clarkson College of Tech., Potsdam, NY 13676, J. Vib. Acoust. Stress Rel. Des., Trans. ASME, 105 (2), pp 232-236 (Apr 1983) 9 figs, 15 refs

Key Words: Finite element technique, Crack propagati

An efficient finite element method has been developed for the computation of time-dependent stress intensity factors for cracks of Mode I deformation in finite bodies. Quarter point elements are used near the crack tip to approximate the theoretical singularity. Problems considered are: the stationary crack subjected to transient loading conditions and the rapidly propagating crack. Advantages of this method with regard to accuracy and savings in computational costs are discussed.

WAVE PROPAGATION
(Also see No. 2388)

83-2521
The Apparent Attenuation of a Scattering Medium
P.G. Richards and W. Menke
School of Oceanography, Oregon State Univ., Corvallis, OR, Bull. Seismol. Soc. Amer., 73 (4), pp 1005-1021 (Aug 1983) 21 figs, 24 refs

Key Words: Wave propagation, Seismic waves, Wave attenuation, Wave diffraction

Results of numerical experiments which bring out the low-pass characteristics of a purely elastic medium with a heterogeneous velocity structure are reported. Although the typical fluctuation is spatially confined within less than a wavelength, waves propagating over a sufficiently long path suffer major cumulative effects. The removal of high frequencies during transmission by a frequency-independent apparent Q are summarized. Some diagnostics that might help to distinguish the presence of velocity fluctuations and resultant scattering from the presence of anelasticity and true dissipation are proposed.

83-2522
Deterministic Methods of Seismic Source Identification
C.B. Archambeau
Cooperative Inst. for Res. in Environmental Science, Boulder, CO, Rept. No. AFOSR-TR-83-0275, 183 pp (Feb 1983)
AD-A127 477

Key Words: Seismic waves, Wave attenuation, Signature analysis

This report emphasizes results from completed research in seismic wave attenuation. Current signal analysis methods using a variety of seismic time series data are also described and illustrated.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

83-2523
Contact Pattern Measurement by Means of Ultrasonic Waves: Art of Present and Some Improvements of Its Performance
Y. Ito and S. Itoh
Dept. of Mech. Engrg. for Production, Tokyo Inst. of Tech., 2-12-1 Ohokayama, Meguro-ku, Tokyo, J. Vib. Acoust. Stress Rel. Des., Trans. ASME, 105 (2), pp 237-241 (Apr 1983) 9 figs, 9 refs

Key Words: Contact pressure, Measurement techniques, Ultrasonic techniques

To understand the contact characteristics of a joint surface, it is necessary to measure the contact pressure. The contact pressure measurement by means of ultrasonic waves (ultrasonic contact pressure measurement) is an effective method and in this paper some improvements of its performance using a focus type transducer are reported.

83-2524

Resonators for Acceleration Environments

T.J. Lukaszek and A. Ballato

Dept. of Army, Washington, DC, U.S. Patent Appl. No. 6-477 204, 13 pp (Mar 21, 1983)

Key Words: Resonators

An arrangement is disclosed for piezoelectric resonators utilizing linear and parallel sides or flats located on the periphery and opposite ends of the resonator.

83-2525

Modal Characterization of Equipment-Continuous Structure Systems

B. Nour-Omid, J.L. Sackman, and A. Der Kiureghian

Dept. of Civil Engrg., Univ. of California, Berkeley, CA 94720, J. Sound Vib., 88 (4), pp 459-472 (June 22, 1983) 3 figs, 2 tables, 9 refs

Key Words: Modal analysis, Equipment response, Natural frequencies, Mode shapes, Damping effects, Mode superposition method

Dynamic properties of a combined linear system composed of a single-degree-of-freedom equipment item attached to a continuous system is obtained by using the appropriate Rayleigh quotient functional. For light equipment, closed form expressions are derived for the approximate natural frequencies, modal functions, and modal dampings of the combined system in terms of the dynamic properties of the continuous system alone and the equipment alone.

83-2526

An Improvement in the Minimal Displacement-to-Frequency Converter

Hsia Chih Shih

Chinese J. Sci. Instrument, 3 (4), pp 407-411 (1982) CSTA 681-82.78

Key Words: Modal analysis, Measuring instruments

Analysis of a new improved minimal displacement-to-frequency converter is presented. This converter is based on application of the emitter coupled timing multivibrator simplifying the structure of the variodenser, the main part of the converter, thus decreasing the capacitance and dimension of the converter. This paper introduces the characteristics of a pressure-to-frequency converter and discusses how to decrease the effect of temperature on frequency.

83-2527

Getting the Most Out of Commercial Modal Systems

R.G. Smiley

Entek Scientific Corp., Cincinnati, OH, S/V, Sound Vib., 17 (6), pp 22-26 (June 1983) 8 figs

Key Words: Modal analysis, Rotational degrees of freedom

This article reviews some of the characteristics of canned modal analysis systems and presents some simple techniques that can be used to greatly enhance the capabilities of (and increase confidence in) their use. Examples include illustrations of problems encountered due to the lack of rotational degrees-of-freedom capabilities and how to avoid these problems; computation of joint and boundary conditions from simple experimental data, including connection points where no data exists; a strategy for designing products to make them more amenable to analysis; and some reasons for the difficulties encountered in predictive analysis.

83-2528

Advanced Analysis Methods Improve Modal Test Results

H. Vold and R. Russell

Structural Dynamics Res. Corp., Milford, OH, S/V, Sound Vib., 17 (3), pp 36-40 (Mar 1983) 12 figs, 2 tables, 8 refs

Key Words: Modal analysis, Modal extraction techniques, Poly Reference method

Modal analysis methods using FFT analyzers and frequency response functions involve various curve fitting techniques to extract mode shapes and modal parameters from measured data. The Poly Reference extraction method described in this

article uses the frequency response function data from all exciter positions simultaneously in the parameter and shape estimation process. This provides a best estimate of all the structural modes with a minimum of user interaction and judgment. Three application examples illustrate how the method provides information about repeated modes or roots and extracts modal information from test articles with high modal density and heavily damped modes.

83-2529

Multiple-Input Method Speeds Space Shuttle Testing

J. Crowley, E. Peterson, and R. Russell

Structural Dynamics Res. Corp., Milford, OH, S/V, Sound Vib., 17 (6), pp 14-20 (June 1983) 12 figs, 4 refs

Key Words: Modal analysis, Frequency response function, Space shuttles, Spacecraft

New data analysis methods have improved the ability to extract modal information (natural frequency, mode shapes and modal parameters) from measured frequency response functions. Accuracy of results is still limited, however, by the basic measurement process. Calibration, signal analysis limitations, and basic assumptions of structural behavior (e.g., linearity, reciprocity and stationarity) combine to make modal analysis using frequency response methods very much an art. A new multi-point random excitation method holds promise for greatly improving the consistency and accuracy of measured frequency response functions. It can assure that basic assumptions on structural behavior are met and significantly reduce data acquisition time for testing complicated structures.

83-2530

Multi-Level Substructural Analysis in Modal Synthesis – Two Improved Substructural Assembling Techniques

Liu Guo Guang, et al

Acta Aeron. et Astron. Sinica, 3 (4), pp 28-35 (1982) CSTA 629.1-82.38

Key Words: Substructuring methods, Modal synthesis

Most of the prevalent modal synthesis methods are referred to as single-level synthesis. Their application to dynamic analysis of large complex structures may be confined by computer capacity. Two improved substructural assembling techniques, multi-level synthesis and successive synthesis, are presented in order to raise computation efficiency and to be available for calculation of large structures on a computer with small interior capacity.

DYNAMIC TESTS

83-2531

Vibration Table Shakes Flaws from Equipment

W.E. Fisher and J.B. Gambill

U.S. Army Construction Engrg. Res. Lab., Indus. Res. and Dev., 25 (8), pp 98-101 (Aug 1983) 4 figs

Key Words: Test facilities, Shock tests, Vibration tests

A biaxial shock testing machine is described. It is capable of testing equipment, structures or models weighing as much as 12,000 lb for resistance to shock at frequencies from 0 to 200 Hz.

83-2532

Calibration of Measurement Channels for Structural Dynamics Testing

D. Corelli and R. Zimmerman

Hewlett-Packard Co., Dayton, OH, S/V, Sound Vib., 17 (3), pp 28-32 (Mar 1983) 5 figs, 1 table

Key Words: Calibrating, Test equipment and instrumentation, Modal tests

It is a common conception that measurements of structural dynamics will be accurate only, at best, to within 10% of the true value. This is often the case, but only if no special efforts are made to obtain greater accuracy. This article describes some calibration methods that can be implemented with minimal investments in special equipment. They are simple and quick enough that any test engineer or technician can perform them as part of a routine test setup.

DIAGNOSTICS

83-2533

Self-Excited Vibration of Statically Unloaded Pads in Tilting-Pad Journal Bearings

M.L.Adams and S. Payandeh

Case Western Reserve Univ., Cleveland, OH 44106,

J. Lubric. Tech., Trans. ASME, 105 (3), pp 377-384 (July 1983) 9 figs, 2 tables, 7 refs

Key Words: Diagnostic techniques, Bearings, Journal bearings, Tilting pad bearings, Self-excited vibrations, Subsynchronous vibration

A time-transient nonlinear dynamic analysis is presented to study the motion of statically unloaded journal-bearing tilting pads. The major finding is that unloaded pads can exhibit a strong sub-synchronous self-excited vibration. The frequency of this periodic motion is somewhat below half the rotational speed and bears a close relationship to self-excited oil-whip vibration of rotors on lightly loaded non-tilting pad journal bearings. The identification of this type of self-excited pad vibration has practical significance to the solution of problems in applications involving damage to unloaded pads. A comprehensive parametric study is presented and shows which tilting-pad journal bearing parameters are significant to self-excited pad vibration and its elimination.

83-2534

Estimating the Severity of Shaft Vibrations within Fluid Film Journal Bearings

J.D. McHugh

General Electric Co., Schenectady, NY 12345, J. Lubric. Tech., Trans. ASME, 105 (3), pp 306-312 (July 1983) 7 figs, 8 refs

Key Words: Shafts, Fluid-film bearings, Vibration measurement, Amplitude analysis, Diagnostic techniques

Proximity probes are being widely used in turbomachinery to measure the amplitude of shaft vibrations within fluid film bearings. There has been, however, little information available for judging the degree of severity of such vibrations. The present paper provides an analysis which correlates shaft vibration amplitude with some basic bearing parameters -- allowable dynamic load on the bearing, its size, geometry, and operating conditions. Curves are provided for several bearing geometries which can be used for a rational estimate of allowable shaft vibration levels.

83-2535

Failure Analysis Methodology

J.N. Robinson and D.O. Cox

Failure Analysis Assoc., Palo Alto, CA, ASME Paper No. 83-PVP-33

Key Words: Failure analysis

The paper lists and discusses the major items that may be included in a failure analysis investigation and that should form part of a failure analysis methodology.

83-2536

Failure Analysis of the World's Largest Grinding Mill

V. Svalbonas

Koppers Co., Inc., York, PA, ASME Paper No. 83-PVP-37

Key Words: Grinding machinery, Failure analysis, Crack propagation

The failure analysis of three of the world's largest grinding mills is documented, from initial fabrication through shell redesign and subsequent replacement. The structures were replaced because of premature cracking in the welds between cylindrical and conical sections.

83-2537

Steam-Turbine Generators -- On-Line Monitoring and Availability

R.L. Bannister, J.C. Bellows, and R.L. Osborne

Westinghouse Electric Corp., Orlando, FL, Mech. Engrg., 105 (7), pp 55-59 (July 1983) 4 figs, 4 refs

Key Words: Diagnostic techniques, Monitoring techniques, Power plants (facilities), Computer-aided techniques

Raising the availability of power plants by means of on-line monitoring and diagnostics is discussed. Characteristics to be monitored include rotor thermal cycles and cracks, water induction, steam purity, generation coolant temperature, abnormal arc, vibration and acoustic emission.

BALANCING

(Also see No. 2567)

83-2538

Changes of the Vibrations of a Flexible Rotor due to

a Change of the Bearings (Die Änderung der Schwingungen eines elastischen Rotors beim Übergang auf andere Lager)

M. Müller
Holegrabestrasse 589a, Ch 5426 Lengnau, Switzerland, Ing. Arch., 53 (3), pp 165-171 (1983) 6 figs, 5 refs
(In German)

Key Words: Balancing techniques, Bearings, Rotors, Flexible rotors

The dynamic characteristics of bearings in balancing machines often differ from those of service bearings of a rotor, so that the vibration of a rotor in a balancing machine differs from that in service. A method for the calculation of the vibration of a rotor mounted in service bearings from its vibration behavior in balancing machine is presented. The imbalance of the rotor does not need to be known; the vibrations are simply measured at the bearings of the balancing machine.

MONITORING

83-2539

Monitoring Mechanical Vibrations Using a Histogram Recorder

J.R. Schnittger
Royal Inst. of Tech. (KTH), Dept. of Machine Elements, Brinellvägen 68, S-10044 Stockholm, Sweden, Intl. J. Fatigue, 5 (3), pp 145-153 (July 1983) 16 figs, 2 tables, 1 ref

Key Words: Monitoring techniques, Rotors, Random vibration, Fatigue life

The problem of fatigue failures originating from random vibrations in machine tools and process machinery calls for new methods of monitoring these machines before demands of higher productivity and increased performance can be met. A laboratory model of a simple rotor system has been built to study different ways in which normal and abnormal conditions of random vibrations may be established. A Datamyte histogram recorder was used to collect, digitize and store the results from the rotor when subject to different degrees of imbalance. It was found that the real-time rainflow and time-at-level and level crossing programs could be used to indicate abnormal vibrations arising from a 0.1% change in rotor mass imbalance.

83-2540

Results of Piping Vibration Monitoring at a Boiling Water Reactor Power Plant

D.E. Olson and J.L.Smetters
Sargent & Lundy Engineers, Chicago, IL, ASME Paper No. 83-PVP-41

Key Words: Monitoring techniques, Piping systems, Nuclear reactor components, Boiling water reactors

Outlined is a visual monitoring procedure for qualifying piping steady-state vibrations and to demonstrate its usability as determined through its implementation during the testing of a BWR nuclear power plant. The procedure is designed to meet the requirements of the governing codes and regulations. The methods given in a recently published piping vibration standard (OM3) are compared to the methods used in the subject procedure.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

83-2541

Negative Mean Stresses – a Source of Calculation Errors (Negative Mittelspannungen – eine Quelle für Fehlrechnungen)

I. Richter
Motoren- und Turbinen-Union Friedrichshafen GmbH Friedrichshafen, Konstruktion, 35 (7), pp 269-271 (July 1983) 2 figs, 8 refs
(In German)

Key Words: Periodic excitation

A number of formulas are given in literature for the calculation of negative mean stresses during synchronous sinusoidal excitation. The investigation shows that with the appearance of negative mean stresses the equations become partially insoluble and sometimes even produce erroneous results. In addition, it is shown that the ambiguity arises when during negative mean stresses the loading is to be regarded as synchronous.

83-2542

Frequency Responses to Minimize Output Disturbances Caused by Parameter Variations and Noise

J.M. Edmunds
Univ. of Manchester Inst. of Science and Tech., Manchester M60 1QD, UK, Intl. J. Control, 38 (1), pp 47-60 (1983) 16 figs, 5 refs

Key Words: Control systems, Frequency response

A combination of feedforward and feedback control leads to a problem of deciding what to do with each. The fundamental differences between these types of control show up when there are unknown disturbances or unknown parameter variations in the system. It is knowledge of the expected sizes of these variations which should influence how the feedforward and feedback should be combined. The paper indicates some of the implications of these relationships in terms of bandwidths. Frequency responses which should optimize the disturbance rejection are found. These optimal results are compared with those from Bode's and Horowitz's ideal frequency characteristics, and with the results expected from minimizing the integral of error-squared on the time responses.

83-2543

Feedback Placement of Eigenvalues for a Hilbert Space Oscillator

R.M. Reid
Dept. of Mathematical and Computer Sciences, Michigan Technological Univ., Houghton, MI 49931, Intl. J. Control, 38 (1), pp 237-244 (1983) 15 refs

Key Words: Eigenvalue problems, Control systems

The effect of a compact linear feedback control on the eigenvalues of a Hilbert space oscillator is considered. It is shown that the kth eigenvalue can be perturbed a distance ϵ_K only if a sequence is summable. Conditions are also derived under which a sequence of complex numbers can be obtained as eigenvalues using such a feedback control. The analysis gives an explicit form for the control in terms of the desired eigenvalues. A simple application to the stabilization problem for water waves in a finite tank is given.

83-2544

Response of Multiple Coupled Dynamic Systems

L.J. Maga and G. Maidanik
David Taylor Naval Ship Res. and Dev. Ctr., Bethesda, MD 20084, J. Sound Vib., 88 (4), pp 473-488 (June 22, 1983) 8 figs, 13 refs

Key Words: Coupled systems, Dynamic systems

Analytical procedures are developed to investigate the nature of the response of multiple coupled dynamic systems. The dynamic systems are one-dimensional and are coupled at junctions. The spatial extents of the dynamic systems are determined by these junctions; a dynamic system terminates at these junctions. The junctions are characterized by assigning reflection and transmission coefficients at the terminal positions of the dynamic systems. In addition, a dynamic system is characterized by a single propagation wavenumber.

83-2545

The Responses of Two-Degree-of-Freedom Systems with Quadratic Nonlinearities to a Parametric Excitation

A.H. Nayfeh
Dept. of Engrg. Science and Mechanics, Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061, J. Sound Vib., 88 (4), pp 547-557 (June 22, 1983) 6 figs, 7 refs

Key Words: Parametric response, Two degree of freedom systems, Harmonic excitation, Plates, Flutter

The method of multiple scales is used to analyze the response of two-degree-of-freedom systems with quadratic nonlinearities to a parametric harmonic excitation having the frequency Ω. Four ordinary differential equations are derived to describe the modulation of the amplitudes and the phases.

83-2546

Using the Variable Transformation in the Simplified Motion Equation of a Prismatic Shaft

M. Dohnal
Res. Inst. SIGMA, Olomouc, Czechoslovakia, Strojnicky Časopis, 34 (3), pp 325-335 (1983) 2 figs, 5 refs
(In Czech)

Key Words: Shafts, Prismatic bodies, Equations of motion

The complete exact solutions of the homogeneous fourth-order partial differential equation with coefficients constant in parts is derived. The differential equation of the same order is obtained by the transformation of the variable with generalized functions on the right side of the equation. Applying the unilateral Laplace transformation the fundamental system of solutions is found which consists of the generalized Krylov's functions. The characteristic equation of the linear boundary-value problem is determined and its eigenvalues are obtained by numerical methods.

83-2547

Diagonalized Consistent Mass Matrix and the Dynamical Finite Element Analysis of Elastic-Plastic Impact in Axisymmetrical Problems

Chien Wei Zang

Appl. Math. and Mechanics, 3 (4), pp 469-490 (1982)

CSTA No. 531-82.112

Key Words: Impact response, Elastic plastic properties, Matrix methods, Finite element technique

The diagonalized consistent mass matrix is found for the triangular ring element in axisymmetrical problems. The results of this work eliminate the uncertainty and arbitrariness of the lumped mass method and the difficulty of computation due to non-diagonalized character of the consistent mass method. The foundations of the finite analysis of elastic-plastic axisymmetrical impact problems are also given.

83-2548

A Family of Houbolt Methods for Dynamic Vibration Problems

R.M. Thomas, C.A. Addison, and I. Gladwell

Dept. of Computer Studies, Univ. of Leeds, Leeds LS2 9JT, UK, Intl. J. Numer. Anal. Methods Geomech., 7 (3), pp 321-336 (July-Sept 1983) 6 figs, 10 tables, 14 refs

Key Words: Houbolt methods, Vibration analysis

The well-known Houbolt method for dynamic vibration problems is extended to a class of methods suitable for a variable-order variable-step computer program implementation. The numerical stability problems of these methods is discussed and a family of extensions with improved stability properties is derived. Numerical results which compare a variety of Houbolt methods with other well-known backward differentiation methods are presented.

83-2549

Effect of the Regulation of Static Compensators on Dynamic Stability of Power Systems

Xue Yu Sheng and Feng Chun Bo

Auto. of Elect. Power Syst., (3), pp 25-39 (1982)

CSTA 621.31-82.188

Key Words: Dynamic stability

A mathematical model for the system of one machine operating through an external impedance against an infinite bus is presented. Based on the small-oscillation theory two forms of dynamic stability loss are discussed. The stability criterion and the analytic equations of stable regions expressed by parameters of both power system and compensator are given. The effects of control variables on dynamical stability are investigated. A linear multivariable control scheme using local state variables is proposed.

83-2550

Finite Element Analysis of Sinusoidal Small-Amplitude Vibrations in Deformed Viscoelastic Solids. Part I: Theoretical Development

K.N. Morman, Jr. and J.C. Nagtegaal

Ford Motor Co., Dearborn, MI, Intl. J. Numer. Methods Engrg., 19 (7), pp 1079-1103 (July 1983) 8 figs, 6 tables, 17 refs

Key Words: Periodic response, Harmonic response, Small amplitudes, Viscoelastic properties, Finite element technique

A general method is presented for the isothermal mechanical analysis of incompressible material solids in which a small-amplitude time harmonic oscillation is superposed on a static finite deformation field.

83-2551

Application of Non-linear Oscillation Methods in the Dynamics of Rigid Bodies

Liu Yan Zhu

J. of Shanghai Chiao Tung Univ. (3), pp 145-154 (1982)

CSTA 621-82.40

Key Words: Nonlinear vibration, Perturbation theory

Nonlinear oscillation methods are extensively applied to resolve the complicated problems of the dynamics of rigid bodies. A survey of the literature on the application of qualitative and approximate analytical methods is made, with special emphasis on the perturbation method of phase coordinates.

83-2552

Free and Forced Motion of a Gyropendulum

V. Krishnan and L. Maunder

Vikram Sarabhai Space Centre, Trivandrum, India, IMechE., Proc., 197, pp 109-115 (June 1983) 9 figs, 3 refs

Key Words: Gyroscopes, Pendulums, Free vibration, Forced vibration

The theory of a gyroscope moving under gravity is extended. Two types of suspension are investigated. In each case results are obtained for free motion and for forced horizontal vibration.

83-2553

On the Dynamic Analysis of Planar Mechanisms with Multiple Clearances

M.O.M. Osman, B.M. Bahgat, and T.S. Sankar

Dept. of Mech. Engrg., Concordia Univ., Montreal, Canada, IMechE., Proc., 197, pp 89-95 (June 1983) 7 figs, 19 refs

Key Words: Mechanisms, Dynamic analysis

A general procedure for the dynamic analysis of planar mechanisms with multiple clearance is developed. The analysis mainly relies on determining the clearance angles B_{ij} its first and second derivatives. The governing equations of each clearance angle are developed. A quick-return motion mechanism with seven clearances is considered to illustrate the procedure.

MODELING TECHNIQUES

83-2554

Modelling and Simulation of Vehicle Bump and Skid Response Using Bond Graphs

M. Hubbard and D. Karnopp

Dept. of Mech. Engrg., Univ. of California, Davis, CA 95616, Intl. J. Vehicle Des., 4 (5), pp 511-523 (Sept 1983) 11 figs, 1 table, 8 refs

Key Words: Mathematical models, Simulation, Ground vehicles, Bond graph technique

A vehicle model and sample simulation results are presented which are used to evaluate safety aspects of full-skid motion and the encountering of large bumps at speed. The model consists of a linearized heave, pitch and roll submodel coupled to nonlinear suspension, tire-force and lateral dynamics submodels. A vector word bond graph provides an overview of the complete system.

83-2555

Compatible Dynamic Finite Elements with Diagonalized Consistent Mass Matrix

Chien Wei Zang

Appl. Math. and Mechanics, 3 (5), pp 565-576 (1982) CSTA 531-82.130

Key Words: Finite element technique, Impact response, Vibration analysis

Compactible dynamic finite elements with diagonalized consistent mass matrix are studied. Compatible form functions are obtained not only for tetrahedron space elements but also for triangular ring elements with diagonalized consistent mass matrices.

83-2556

Improvement of a Large Analytical Model Using Test Data

A. Berman and E.J. Nagy

Kaman Aerospace Corp., Bloomfield, CT, AIAA J., 21 (8), pp 1168-1173 (Aug 1983) 1 fig, 5 tables, 21 refs

Key Words: Mathematical models

A method is developed which uses measured normal modes and natural frequencies to improve an analytical mass and stiffness matrix model of a structure. The method directly identifies, without iteration, a set of minimum changes in the analytical matrices which force the eigensolutions to agree with the test measurements.

83-2557

Trimming the Fat from Finite-Element Matrices

T. Havas

Lockheed Missiles and Space Co., Palo Alto, CA, Mach. Des., 55 (16), pp 99-102 (July 7, 1983) 2 figs

Key Words: Finite element technique, Matrix reduction method

The row-by-row matrix reduction and the total matrix reduction techniques for processing complex finite element problems, which consume very little processing time, are described. In dynamic analysis the results for lower frequencies representing basic structural behavior show excellent agreement with original matrix. Results for higher frequencies are rougher approximations but are satisfactory for showing coarse structural behavior.

NUMERICAL METHODS

83-2558

Elements for the Numerical Analysis of Wave Motion in Layered Strata

J.L. Tassoulas and E. Kausel

Dept. of Civil Engrg., The Univ. of Texas, Austin, TX, Intl. J. Numer. Methods Engrg., 19 (7), pp 1005-1032 (July 1983) 7 figs, 13 refs

Key Words: Numerical analysis, Wave propagation, Layered materials, Footings, Finite element technique

A technique is developed for the numerical analysis of wave motion in layered strata. Semidiscrete particular solutions satisfying inhomogeneous boundary conditions are calculated by the finite element method. These solutions are combined with semidiscrete modes of an appropriate eigenvalue problem. The boundary conditions corresponding to rigid and rough footings on a layered stratum are treated in detail. Applications are considered which demonstrate the validity of the technique.

83-2559

Some New Developments in Non-linear Vibration Theory of Discrete Systems

Ling Fu Hua

J. of Shanghai Chiao Tung Univ. (4), pp 155-170 (1982)

CSTA 621-82.41

Key Words: Numerical analysis, Nonlinear vibration

Due to the wide application of computers and improved numerical methods, research on nonlinear vibration has developed and many new results have been presented. Application of the direct integration method is quite remarkable. The problem of finding periodic solutions of nonlinear vibration systems is regarded as a two-point boundary-value problem and is treated with shooting methods. Under certain conditions steady solutions of deterministic equations present random behavior. This chaotic behavior is studied using the point mapping method.

83-2560

A Numerical Method for the Forced Nonlinear Vibration

O.H. Kim and B.H. Lee

Dept. of Mech. Engrg., Korea Advanced Inst. of Science and Tech., Seoul, Korea, Mech. Res. Comm., 10 (3), pp 151-156 (1983) 5 figs, 5 refs

Key Words: Numerical analysis, Forced vibration, Nonlinear vibration

When system dynamics include nonlinearity and discontinuity, it is difficult to solve the steady state response of the system to excitation. Description of a numerical method, based on the fundamental assumption that the steady-state response of the system is periodic, is presented. The method is demonstrated through some examples where solutions having the same period of excitation are derived.

83-2561

Idealized Dynamic Grid Computation of Physical Systems

J.C. Anyiwo

NASA Langley Res. Ctr., Hampton, VA, 22 pp (1982) (Numerical Grid Generation, Proc. of Symposium on Numerical Generation of Curvilinear Coordinate Systems and their Use in the Numerical Solution of Partial Differential Equations, Apr 1982, Nashville, TN)

AD-A127 498

Key Words: Numerical analysis, Finite difference technique

The construction and utility of an idealized computational space for finite-difference computation of physical systems is considered.

PARAMETER IDENTIFICATION

(See No. 2408)

OPTIMIZATION TECHNIQUES

83-2562

A Dynamic Hunting Optimizing Controller

Liu Wan Chiang and Wu Tian Fu

Chinese J. Sci. Instrument, 3 (4), pp 374-381 (1982)

CSTA 681-82.75

Key Words: Optimization, Control systems, Hunting motion

The fundamental principle and design method of an optimizing controller with dynamic hunting is explained in accordance with the control theory. This controller can be used in a process control system.

83-2563

A Time-Domain Parameter Optimization Algorithm for Control Systems

Z.S. Wang and A.A. Seireg

Univ. of Wisconsin-Madison, Madison, WI, Computers Mech. Engrg., 2 (1), pp 73-81 (July 1983) 9 figs, 3 tables, 22 refs

Key Words: Optimization, Time-domain method, Dynamic stability

The method is based on a time-domain formulation which is deduced from analytically integrating the quadratic function by using the modal matrix. The quadratic integral and stability constraints can be estimated simultaneously and systematically. The search algorithm uses an augmented penalty function. Optimum solutions with guaranteed stability can be achieved without concern as to whether the starting point is in a stable or unstable region.

COMPUTER PROGRAMS

(Also see No. 2355)

83-2564

MASON: Frequency Response Calculation of Control Systems

L.C. Boger

Detroit Diesel Allison, Indianapolis, IN, Mag. tape NTIS/DF-83/007 (Sept 1982)

PB83-192195

Key Words: Computer programs, Frequency response, Control systems

MASON is a frequency response computer program useful in the design and analysis of control systems. Complex signal flowgraphs involving either Laplace transform or Z-transform transmittances are reduced via a computational algorithm based on Mason's gain formula. The transmittances may include nonlinear transfer functions such as transport lags or actual gain/phase data from experimental testing. The input structure is user oriented providing for simple transfer function representation between nodes.

83-2565

User's Manual for Using MASON: A Frequency Response Program which Handles Any System of Transfer Functions Described by a Signal Flow Graph

L.C. Boger

Detroit Diesel Allison, Indianapolis, IN, Rept. No. DDAD/EDR-11187, NTIS/DF-83/007A, 85 pp (Sept 1982)

PB83-192187

Key Words: Computer programs, Frequency response, Control systems

MASON is a frequency response computer program useful in the design and analysis of linear control systems. Complex signal flowgraphs involving either Laplace transform or Z-transform transmittances are reduced via a computational algorithm based on Mason's gain formula. The transmittances may include nonlinear transfer functions such as transport lags or actual gain/phase data from experimental testing. The input structure is user oriented providing for simple transfer function representation between nodes. Frequency response, resonant peak, resonant frequency and gain and phase margin are calculated where appropriate and form the program output.

83-2566

Computer Program ADSR-2 for the Torsional Analysis of Drives (Programmsystem ADSR 2 zur Drehschwingungsanalyse von Antriebsätzen)

Konstruktion, 35 (7), p 289 (July 1983)

(In German)

Key Words: Computer programs, Torsional vibration, Mechanical drives, Shafts, Gears

The program ADSR-2 is described which is used for the calculation of torsional vibrations of drivelines with one- or multistep spur gears, and planetary gear steps with one or more planetary wheels. The program can also calculate all natural frequencies and mode shapes of a system from a dynamic model. Furthermore, the additional dynamic loads on shafts and gear teeth caused by forces and deflection excitation can also be determined. Interested parties should address their inquiries to the editorial staff of 'Konstruktion', Springer-Verlag, Otto-Suhr-Allee 26-28, D-1000 Berlin 10.

GENERAL TOPICS

CRITERIA, STANDARDS, AND SPECIFICATIONS

83-2567
Procedures for Balancing of Flexible Rotors
American National Standards Institute, ANSI S2.42-1982 (ASA 46-1982)

Key Words: Standards and codes, Balancing techniques, Rotors

The standard contains a classification of rotors into groups according to their balancing requirements as influenced by the flexural stiffness and imbalance distribution of the rotor. Certain classes of rotors can be balanced by normal or modified rigid rotor techniques. Other more flexible rotors sometimes require high-speed balancing. The purpose of the standard is to provide direction on avoiding gross deficiencies or unattainable requirements. The fundamentals of flexible rotor balancing are discussed as well as methods for assessing final imbalance. Guidance is given for judging final balance quality.

PERIODICALS SCANNED

ACTA MECHANICA
(Acta Mech.)
Springer-Verlag New York, Inc.
175 Fifth Ave.
New York, NY 10010

ACTA MECHANICA SOLIDA SINICA
(Acta Mech. Solida Sinica, Chinese Soc. Theo. Appl. Mech.)
Chinese Society of Theoretical and Applied Mechanics
Guozi Shudian
P.O. Box 399
Beijing, China

ACUSTICA
(Acustica)
S. Hirzel Verlag, Postfach 40
7000 Stuttgart 1
West Germany

AERONAUTICAL JOURNAL
(Aeronaut. J.)
Royal Aeronautical Society
4 Hamilton Pl.
London W1V 0BQ, UK

AERONAUTICAL QUARTERLY
(Aeronaut. Quart.)
Royal Aeronautical Society
4 Hamilton Pl.
London W1V 0BQ, UK

AIAA JOURNAL
(AIAA J.)
American Institute of Aeronautics and Astronautics
1633 Broadway
New York, NY 10019

AMERICAN SOCIETY OF CIVIL ENGINEERS, PROCEEDINGS
(ASCE, Proc.)
ASCE
United Engineering Center
345 E. 47th St.
New York, NY 10017

JOURNAL OF ENGINEERING MECHANICS
(ASCE J. Engrg. Mech.)

JOURNAL OF STRUCTURAL ENGINEERING
(ASCE J. Struc. Engrg.)

AMERICAN SOCIETY OF LUBRICATION ENGINEERS, TRANSACTIONS
(ASLE, Trans.)
ASLE
838 Busse Highway
Park Ridge, IL 60068

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, TRANSACTIONS
(Trans. ASME)
ASME
United Engineering Center
345 E. 47th St.
New York, NY 10017

JOURNAL OF APPLIED MECHANICS
(J. Appl. Mech., Trans. ASME)

JOURNAL OF DYNAMIC SYSTEMS, MEASUREMENT AND CONTROL
(J. Dynam. Syst., Meas. Control, Trans. ASME)

JOURNAL OF ENERGY RESOURCES TECHNOLOGY
(J. Energy Resources Tech., Trans. ASME)

JOURNAL OF ENGINEERING FOR INDUSTRY
(J. Engrg. Indus., Trans. ASME)

JOURNAL OF ENGINEERING FOR POWER
(J. Engrg. Power, Trans. ASME)

JOURNAL OF LUBRICATION TECHNOLOGY
(J. Lubric. Tech., Trans. ASME)

JOURNAL OF PRESSURE VESSEL TECHNOLOGY
(J. Pressure Vessel Tech., Trans. ASME)

JOURNAL OF VIBRATION, ACOUSTICS, STRESS, AND RELIABILITY IN DESIGN
(J. Vib., Acoust., Stress, Rel. Des., Trans. ASME)

APPLIED ACOUSTICS
(Appl. Acoust.)
Applied Science Publishers, Ltd.
Ripple Road, Barking
Essex, UK

ARCHIVE OF APPLIED MECHANICS
(Arch. Appl. Mech.)
Springer-Verlag
44 Hartz Way
Secaucus, NJ 07094

ASTRONAUTICS AND AERONAUTICS
(Astronaut. Aeronaut.)
American Institute of Aeronautics and Astronautics
1633 Broadway
New York, NY 10019

AUTOMOBILTECHNISCHE ZEITSCHRIFT
(Automobiltech. Z.)
Franckh'sche Verlagshandlung
Abteilung Technik
7000 Stuttgart 1
Pfizerstrasse 5-7
West Germany

AUTOMOTIVE ENGINEER (UK)
(Auto. Engr. (UK)
Mechanical Engineering Publications Ltd.
P.O. Box 24
Northgate Ave., Bury St. Edmunds
Suffolk IP32 6BW, UK

AUTOMOTIVE ENGINEERING (SAE)
(Auto. Engrg. (SAE))
Society of Automotive Engineers, Inc.
400 Commonwealth Dr.
Warrendale, PA 15096

BALL BEARING JOURNAL (English Edition)
(Ball Bearing J.)
SKF (U.K.) Ltd.
Luton, Bedfordshire
LU3 3BL, UK

BROWN BOVERI REVIEW
(Brown Boveri Rev.)
Brown Boveri and Co., Ltd.
CH-5401, Baden Switzerland

BULLETIN OF JAPAN SOCIETY OF MECHANICAL ENGINEERS
(Bull. JSME)
Japan Society of Mechanical Engineers
Sanshin Hokusei Bldg.
H-9 Yoyogi 2-chome Shibuya-ku
Tokyo 151, Japan

CANADIAN JOURNAL OF CIVIL ENGINEERING
(Can. J. Civ. Engrg.)
National Research Council of Canada
Ottawa, Canada K1A OR6

CHARTERED MECHANICAL ENGINEER
(Chart. Mech. Engr.)
Institution of Mechanical Engineers
P.O. Box 24
Northgate Ave., Bury St. Edmunds
Suffolk IP32 6BW, UK

CHINA SCIENCE AND TECHNOLOGY ABSTRACTS
(China Sci. Tech. Abstracts)
International Information Service Ltd.
P.O. Box 24683
ABD Post Office, Hong Kong

CIVIL ENGINEERING (NEW YORK)
(Civ. Engrg. (NY))
ASCE
United Engineering Center
345 E. 47th St.
New York, NY 10017

COMPUTERS AND STRUCTURES
(Computers Struc.)
Pergamon Press Inc.
Maxwell House, Fairview Park
Elmsford, NY 10523

COMPUTERS IN MECHANICAL ENGINEERING
(Computers Mech. Engrg.)
ASME
United Engineering Center
345 E. 47th St.
New York, NY 10017

DESIGN NEWS
(Des. News)
Cahners Publishing Co., Inc.
221 Columbus Ave.
Boston, MA 02116

DIESEL PROGRESS
(Diesel Prog.)
Diesel Progress
13555 Bishop's Ct.
Brookfield, WI 53035

EARTHQUAKE ENGINEERING AND STRUCTURAL DYNAMICS
(Earthquake Engrg. Struc. Dynam.)
John Wiley & Sons Ltd.
Baffins Lane
Chichester, Sussex PO19 1UD, England

ELECTRONIC PRODUCTS
(Electronic Prod.)
Hearst Business Communications, Inc.
P.O. Box 730
Garden City, NY 11530

ENGINEERING STRUCTURES
(Engrg. Struc.)
IPC Science and Technology Press Ltd.
Westbury House
P.O. Box 63, Bury St.
Guildford, Surrey GU2 5BH, UK

EXPERIMENTAL MECHANICS
(Exptl. Mech.)
Society for Experimental Stress Analysis
14 Fairfield Dr.
Brookfield Center, CT 06805

EXPERIMENTAL TECHNIQUES
(Expt. Tech.)
Society for Experimental Stress Analysis
14 Fairfield Dr.
Brookfield Center, CT 06805

FEINGERÄTETECHNIK
(Feingerätetechnik)
VEB Verlag Technik
Berlin, E. Germany

FEINWERKTECHNIK UND MESSTECHNIK
(Feinwerktech. u. Messtech.)
Carl Hanser Verlag
Postfach 860420
D-8000 München 86
Fed. Rep. Germany

FERTIGUNGSTECHNIK UND BETRIEB
(Fertigungstech. u. Betrieb)
VEB Verlag Technik
Postfach 293
102 Berlin, E. Germany

FORSCHUNG IM INGENIEURWESEN
(Forsch. Ingenieurwesen)
Verein Deutscher Ingenieur, GmbH
Postfach 1139
Graf-Recke Str. 84
4 Düsseldorf 1, W. Germany

GUMMI ASBEST KUNSTSTOFFE
(Gummi Asbest Kunstst.)
A.W. Gentner Verlag GmbH & Co. KG
Forststrasse 131, Postfach 688
7000 Stuttgart 1, W. Germany

HEATING/PIPING/AIR CONDITIONING
(Heating/Piping/Air Cond.)
Circulation Dept.
614 Superior Ave. West
Cleveland, OH 44113

HEBEZEUGE UND FORDERMITTEL
(Hebezeuge u. Fordermittel)
VEB Verlag Technik
102 Berlin
Postfach 293
E. Germany

HIGH TECHNOLOGY
(High Tech.)
Subscription Service Dept.
P.O. Box 2528
Boulder, CO 80322

HYDRAULICS AND PNEUMATICS
(Hydraul. Pneumat.)
Penton/IPC, Inc.
614 Superior Ave. West
Cleveland, OH 44113

HYDROCARBON PROCESSING
(Hydrocarbon Processing)
Gulf Publishing Co.
P.O. Box 2608
Houston, TX 77001

IBM JOURNAL OF RESEARCH AND DEVELOPMENT
(IBM J. Res. Dev.)
International Business Machines Corp.
Armonk, NY 10504

INDUSTRIAL LUBRICATION AND TRIBOLOGY
(Indus. Lubric. Trib.)
Peterson Publishing Co. Ltd.
Peterson House, Northbank,
Berryhill Industrial Estate
Droitwich, Worcs WR9 9BL, England

INDUSTRIAL RESEARCH AND DEVELOPMENT
(Indus. Res. Dev.)
P.O. Box 1030
Barrington, IL 60010

INGENIEUR-ARCHIV
(Ing. Arch.)
Springer-Verlag New York, Inc.
175 Fifth Ave.
New York, NY 10010

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, PROCEEDINGS
(IEEE, Proc.)
IEEE
United Engineering Center
345 E. 47th St.
New York, NY 10017

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, TRANSACTIONS
(IEEE, Trans.)
445 Hoes Lane
Piscataway, NJ 08854

INDUSTRIAL ELECTRONICS
(Indus. Electronics)

INDUSTRY APPLICATIONS
(Indus. Applic.)

INSTRUMENTATION AND MEASUREMENT
(Instrum. Meas.)

POWER APPARATUS AND SYSTEMS
(Power Apparatus Syst.)

VEHICULAR TECHNOLOGY
(Vehicular Tech.)

INSTITUTE OF MARINE ENGINEERS, TRANSACTIONS (TM)
(Inst. Marine Engr., Trans. (TM))
Institute of Marine Engineers
76 Mark Lane
London EC3R 7JN, UK

INSTITUTE OF MEASUREMENT AND CONTROL, TRANSACTIONS
(Inst. Meas. Control, Trans.)
Institute of Measurement and Control
20 Peel St.
London W8 7PD, UK

INSTITUTION OF MECHANICAL ENGINEERS, PROCEEDINGS, PART C: MECHANICAL ENGINEERING SCIENCE
(IMechE, Proc.)
Institution of Mechanical Engineers
1 Birdcage Walk, Westminster,
London SW1, UK

INSTRUMENT SOCIETY OF AMERICA, TRANSACTIONS
(ISA Trans.)
Instrument Society of America
400 Stanwix St.
Pittsburgh, PA 15222

INSTRUMENTATION TECHNOLOGY
(Instrum. Tech.)
Instrument Society of America
67 Alexander Dr.
P.O. Box 12277
Research Triangle Park, NC 27709

INTERNATIONAL JOURNAL OF CONTROL
(Intl. J. Control)
Taylor and Francis Ltd.
10-14 Macklin St.
London WC2B 5NF, UK

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCE
(Intl. J. Engrg. Sci.)
Pergamon Press Inc.
Maxwell House, Fairview Park
Elmsford, NY 10523

INTERNATIONAL JOURNAL OF FATIGUE
(Intl. J. Fatigue)
Butterworth Scientific Ltd.
Journals Div.,
P.O. Box 63, Westbury House, Bury St.
Guildford GU2 5BH, Surrey, UK

INTERNATIONAL JOURNAL OF IMPACT ENGINEERING
(Intl. J. Impact Engrg.)
Pergamon Press Inc.
Maxwell House, Fairview Park
Elmsford, NY 10523

INTERNATIONAL JOURNAL OF MACHINE TOOL DESIGN AND RESEARCH
(Intl. J. Mach. Tool Des. Res.)
Pergamon Press Inc.
Maxwell House, Fairview Park
Elmsford, NY 10523

INTERNATIONAL JOURNAL OF MECHANICAL SCIENCES
(Intl. J. Mech. Sci.)
Pergamon Press Inc.
Maxwell House, Fairview Park
Elmsford, NY 10523

INTERNATIONAL JOURNAL OF NONLINEAR MECHANICS
(Intl. J. Nonlin. Mech.)
Pergamon Press Inc.
Maxwell House, Fairview Park
Elmsford, NY 10523

INTERNATIONAL JOURNAL FOR NUMERICAL AND ANALYTICAL METHODS IN GEOMECHANICS
(Intl. J. Numer. Anal. Methods Geomech.)
John Wiley & Sons Ltd.
Baffins Lane
Chichester, Sussex PO19 1UD, England

INTERNATIONAL JOURNAL FOR NUMERICAL METHODS IN ENGINEERING
(Intl. J. Numer. Methods Engrg.)
John Wiley & Sons Ltd.
Baffins Lane
Chichester, Sussex PO19 1UD, England

INTERNATIONAL JOURNAL OF SOLIDS AND STRUCTURES
(Intl. J. Solids Struc.)
Pergamon Press Inc.
Maxwell House, Fairview Park
Elmsford, NY 10523

INTERNATIONAL JOURNAL OF VEHICLE DESIGN
(Intl. J. Vehicle Des.)
Inderscience Enterprises Ltd.
La Motte Chambers, St. Helier,
Jersey, Channel Islands, UK

ISRAEL JOURNAL OF TECHNOLOGY
(Israel J. Tech.)
Weizmann Science Press of Israel
Box 801
Jerusalem, Israel

JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA
(J. ASA)
American Institute of Physics
335 E. 45th St.
New York, NY 10010

JOURNAL OF AIRCRAFT
(J. Aircraft)
American Institute of Aeronautics and Astronautics
1633 Broadway
New York, NY 10019

JOURNAL OF ENGINEERING MATHEMATICS
(J. Engrg. Math.)
Academic Press
198 Ash St.
Reading, MA 01867

JOURNAL OF ENVIRONMENTAL SCIENCES
(J. Environ. Sci.)
Institute of Environmental Sciences
940 E. Northwest Highway
Mt. Prospect, IL 60056

JOURNAL OF THE FRANKLIN INSTITUTE
(J. Franklin Inst.)
Pergamon Press Inc.
Maxwell House, Fairview Park
Elmsford, NY 10523

JOURNAL OF HYDRONAUTICS
(J. Hydronautics)
American Institute of Aeronautics and Astronautics
1290 Avenue of the Americas
New York, NY 10104

JOURNAL DE MÉCANIQUE THÉORIQUE ET APPLIQUÉE
(J. de Mécanique Théor. Appl.)
Gauthier-Villars
C.D.R. - Centrale des Revues
B.P. No. 119, 93104 Montreuil Cedex-France

JOURNAL OF THE MECHANICS AND PHYSICS OF SOLIDS
(J. Mech. Phys. Solids)
Pergamon Press Inc.
Maxwell House, Fairview Park
Elmsford, NY 10523

JOURNAL OF PETROLEUM TECHNOLOGY
(J. Pet. Tech.)
Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, TX 75206

JOURNAL OF PHYSICS, E: SCIENTIFIC INSTRUMENTS
(J. Phys., E: Sci. Instrum.)
American Institute of Physics
335 E. 45th St.
New York, NY 10017

JOURNAL OF SHIP RESEARCH
(J. Ship Res.)
Society of Naval Architects and Marine Engineers
One World Trade Center
Suite 1369
New York, NY 10048

JOURNAL OF SOUND AND VIBRATION
(J. Sound Vib.)
Academic Press Inc.
111 Fifth Ave.
New York, NY 10003

JOURNAL OF SPACECRAFT AND ROCKETS
(J. Spacecraft Rockets)
American Institute of Aeronautics and Astronautics
1633 Broadway
New York, NY 10019

JOURNAL OF STRUCTURAL MECHANICS
(J. Struc. Mech.)
Marcel Dekker, Inc.
270 Madison Ave.
New York, NY 10016

JOURNAL OF TESTING AND EVALUATION (ASTM)
(J. Test Eval. (ASTM))
American Society for Testing and Materials
1916 Race St.
Philadelphia, PA 19103

KONSTRUKTION
(Konstruktion)
Springer-Verlag
3133 Connecticut Ave., N.W., Suite 712
Washington, DC 20008

KONSTRUKTION ELEMENTE METHODEN
(Konstruktion Elemente Meth.)
Konradin-Verlag
Postfach 10 02 52
7022 Leinfelden-Echterdingen
W. Germany

LUBRICATION ENGINEERING
(Lubric. Engrg.)
American Society of Lubrication Engineers
838 Busse Highway
Park Ridge, IL 60068

MACHINE DESIGN
(Mech. Des.)
Penton/IPC, Inc.
Penton Plaza, 1111 Chester Ave.
Cleveland, OH 44114

MACHINERY AND STEEL (AUSTRIA)
(Machinery and Steel (Austria))
Fachverband d. Maschinen- und
Stahlbauindustrie Österreichs
Bauernmarkt 13
1011 Wien, Austria

MASCHINENBAUTECHNIK
(Maschinenbautech.)
VEB Verlag Technik
Oranienburger Str. 13/14
1020 Berlin, E. Germany

MASCHINENMARKT
(Maschinenmarkt)
Vogel Verlag KG
Max-Planck Str. 7
Postfach 6740
8700 Wurzburg 1, E. Germany

DER MASCHINENSCHADEN
(der Maschinenschaden)
Köniqinstrasse 28
D-8000 München 44
W. Germany

MECCANICA
(Meccanica)
Pergamon Press Inc.
Maxwell House, Fairview Park
Elmsford, NY 10523

MECHANICAL ENGINEERING
(Mech. Engrg.)
American Society of Mechanical Engineers
United Engineering Center
345 E. 47th St.
New York, NY 10017

MECHANICS RESEARCH COMMUNICATIONS
(Mech. Res. Comm.)
Pergamon Press Inc.
Maxwell House, Fairview Park
Elmsford, NY 10523

MECHANISM AND MACHINE THEORY
(Mech. Mach. Theory)
Pergamon Press Inc.
Maxwell House, Fairview Park
Elmsford, NY 10523

MESSEN/STEUERN/REGELN
Messen/Steuern/Regeln)
VEB Verlag Technik
DDR-1020 Berlin
Oranienburger St. 13-14
Postfach 201, E. Germany

MICROTECNIC
(Microtecnic)
Agifa Verlag
Universitätstrasse 94
P.O. Box 257
CH-8033 Zürich, Switzerland

MTZ MOTORTECHNISCHE ZEITSCHRIFT
(MTZ Motortech. Z.)
Franckh'sche Verlagshandlung
Pfizerstrasse 5-7
7000 Stuttgart 1, W. Germany

NAVAL ENGINEERS JOURNAL
(Naval Engr. J.)
American Society of Naval Engineers, Inc.
Suite 507, Continental Building
1012 14th St., N.W.
Washington, DC 20005

NDT INTERNATIONAL
(NDT Intl.)
Butterworth Scientific
P.O. Box 63, Westbury House, Bury St.
Guildford, Surrey GU2 5BH, UK

NOISE CONTROL ENGINEERING
(Noise Control Engrg.)
P.O. Box 2306, Arlington Branch
Poughkeepsie, NY 12603

NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS, TRANSACTIONS
(NE Coast Instn. Engr. Shipbldr., Trans.)
Bolbec Hall
Newcastle upon Tyne 1, UK

NUCLEAR ENGINEERING AND DESIGN
(Nucl. Engrg. Des.)
North-Holland Publishing Co.
P.O. Box 3489
Amsterdam, The Netherlands

PAPER TECHNOLOGY AND INDUSTRY
(Paper Tech. Indus.)
3, Plough Place, Fetter Lane
London EC4A, 1AL, UK

PLANT ENGINEERING
(Plant Engrg.)
Technical Publishing Co.
1301 S. Grove Ave.
Barrington, IL 60010

POWER
(Power)
P.O. Box 430
Hightstown, NJ 08520

POWER TRANSMISSION DESIGN
(Power Transm. Des.)
1111 Chester Ave.
Cleveland, OH 44114

QUARTERLY JOURNAL OF MECHANICS AND APPLIED MATHEMATICS
(Quart. J. Mech. Appl. Math.)
Wm. Dawson & Sons, Ltd.
Cannon House
Folkestone, Kent, UK

REVUE ROUMAINE DES SCIENCES TECHNIQUES, SERIE DE MECANIQUE APPLIQUEE
(Rev. Roumaine Sci. Tech., Mecanique Appl.)
Editions de l'Academie
De la Republique Socialiste de Roumaine
3 Bis Str., Gutenberg, Bucharest, Romania

REVIEW OF SCIENTIFIC INSTRUMENTS
(Rev. Scientific Instrum.)
American Institute of Physics
335 E. 45th St.
New York, NY 10017

SAE TECHNICAL LITERATURE ABSTRACTS
(SAE Tech. Lit. Abstracts)
Society of Automotive Engineers
400 Commonwealth Dr.
Warrendale, PA 15086

SCIENTIFIC AMERICAN
(Scientific American)
415 Madison Ave.
New York, NY 10017

SHOCK AND VIBRATION DIGEST
(Shock Vib. Dig.)
Shock and Vibration Information Center
Naval Research Laboratory, Code 5804
Washington, DC 20375

SIAM JOURNAL ON APPLIED MATHEMATICS
(SIAM J. Appl. Math.)
Society for Industrial and Applied Mathematics
1405 Architects Building
117 S. 17th St.
Philadelphia, PA 19103

SIEMENS RESEARCH AND DEVELOPMENT REPORTS
(Siemens Res. Dev. Repts.)
Springer-Verlag New York Inc.
175 Fifth Ave.
New York, NY 10010

STROJNÍCKY ČASOPIS
(Strojnícky Časopis)
Redakcia Strojnickeho Časopisu ČSAV a SAV
Ústav Mechaniky Strojov SAV
Bratislava-Patrónka, Dúbravská cesta, ČSSR
Czechoslovakia

STRUCTURAL ENGINEER, PARTS A & B
(Struc. Engr.)
The Institution of Structural Engineers
11 Upper Belgrave St.
London SW1X 8BH, UK

S/V, SOUND AND VIBRATION
(S/V, Sound Vib.)
Acoustic Publications, Inc.
27101 E. Oviat Rd.
P.O. Box 40416
Bay Village, OH 44140

TAPPI JOURNAL
(TAPPI J.)
Technical Association of the Pulp and Paper Industry
15 Technology Park South
Norcross, GA 30092

TECHNICAL NEWS
(Tech. News)
Perkin-Elmer
Editorial Office
Optical Group
100 Wooster Heights
Danbury, CT 06810

TECHNICAL REVIEW
(Tech. Rev.)
Bruel & Kjaer
185 Forest St.
Marlborough, MA 01752

TECHNISCHES MESSEN - TM
(Techn. Messen-TM)
R. Oldenbourg Verlag GmbH
Rosenheimer Strasse 145
8000 München 80, W. Germany

TEST
(Test)
Mattingley Publishing Co., Inc.
61 Monmouth Rd.
Oakhurst, NJ 07755

TRIBOLOGY INTERNATIONAL
(Trib. Intl.)
Butterworth Scientific Ltd., Journals Div.
P.O. Box 63, Westbury House, Bury St.
Guildford, Surrey GU2 5BH, UK

TURBOMACHINERY INTERNATIONAL
(Turbomachinery Intl.)
270 Madison Ave.
New York, NY 10016

VDI BERICHTE
(VDI Ber.)
Verein Deutscher Ingenieur GmbH
Postfach 1139, Graf-Recke Str. 84
4 Düsseldort 1, W. Germany

VDI FORSCHUNGSHEFT
(VDI Forsch.)
Verein Deutscher Ingenieur GmbH
Postfach 1139, Graf-Recke Str. 84
4 Düsseldorf 1, W. Germany

VDI ZEITSCHRIFT
(VDI Z.)
Verein Deutscher Ingenieur GmbH
Postfach 1139, Graf-Recke Str. 84
4 Düsselforf 1, W. Germany

VEHICLE SYSTEM DYNAMICS
(Vehicle Syst. Dynam.)
Swets & Zeitlinger B.V.
Publishing Dept.
347 B, Heereweg, 2161 CA LISSE
The Netherlands

VERTICA
(Vertica)
Pergamon Press
Maxwell House, Fairview Park
Elmsford, NY 10523

VIBROTECHNIKA
(Vibrotechnika)
Kauno Polytechnikos Institutas
2 Donelaičio g-ve 17
233000 Kaunas, Lithuanian SSR

WAVE MOTION
(Wave Motion)
North-Holland Publishing Co.
Journal Div.
Molenwerf 1, P.O. Box 211
1000 AE Amsterdam, The Netherlands

WEAR
(Wear)
Elsevier-Sequoia S.A.
P.O. Box 851
1001 Lausanne 1, Switzerland

ZEITSCHRIFT FUR ANGEWANDTE MATHEMATIK UND MECHANIK
(Z. angew. Math. Mech.)
Akademie Verlag GmbH
Liepziger Str. 3-4
108 Berlin, E. Germany

ZEITSCHRIFT FUR FLUGWISSENSCHAFTEN
(Z. Flugwiss.)
DFVLR
D-3300 Braunschweig
Flughafen, Postfach 3267, W. Germany

SECONDARY PUBLICATIONS SCANNED

DISSERTATION ABSTRACTS INTERNATIONAL
(DA)
University Microfilms International
300 N. Zeeb Rd.
Ann Arbor, MI 48106

GOVERNMENT REPORTS ANNOUNCEMENTS & INDEX
(GRA)
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Rd.
Springfield, VA 22161

PROCEEDINGS SCANNED

INSTITUTE OF ENVIRONMENTAL SCIENCES, ANNUAL PROCEEDINGS
(IES, Proc.)
Institute of Environmental Sciences
940 E. Northwest Highway
Mt. Prospect, IL 60056

INTERNATIONAL CONFERENCE, VIBRATIONS IN ROTATING MACHINERY
(Intl. Conf., Vib. Rotating Mach.)
The Institution of Mechanical Engineers
1 Birdcage Walk, Westminster
London SW1H 9JJ, UK

INTER-NOISE PROCEEDINGS, INTERNATIONAL CONFERENCE ON NOISE CONTROL ENGINEERING
(Inter-Noise)
Noise Control Foundation
P.O. Box 3469, Arlington Branch
Poughkeepsie, NY 12603

MACHINERY VIBRATION MONITORING AND ANALYSIS MEETING, PROCEEDINGS
(Mach. Vib. Monit. Anal., Proc.)
The Vibration Institute
101 W. 55th St., Suite 206
Clarendon Hills, IL 60514

NOISE CONTROL PROCEEDINGS, NATIONAL CONFERENCE ON NOISE CONTROL ENGINEERING
(Noise Control)
Noise Control Foundation
P.O. Box 3469, Arlington Branch
Poughkeepsie, NY 12603

THE SHOCK AND VIBRATION BULLETIN, UNITED STATES NAVAL RESEARCH LABORATORIES, ANNUAL PROCEEDINGS
(Shock Vib. Bull., U.S. Naval Res. Lab., Proc.)
Shock and Vibration Information Center
Naval Research Lab., Code 5804
Washington, DC 20375

TURBOMACHINERY SYMPOSIUM
(Turbomachinery Symp.)
Gas Turbine Labs.,
Texas A&M University
College Station, TX 77843

FEATURE ARTICLES

LITERATURE REVIEWS

	ISSUE	PAGES
Greif, R. and Wu, L. **Substructure Analysis of Vibrating Systems**	1	17-24
Rizai, M.N., Bernard, J.E., and Starkey, J.M. **Empirical Modal Analysis**	1	25-30
Done, G.T.S. **Further Advances in Helicopter Vibration Control**	2	17-22
Jensen, J.J. **Beam Models for Ship Hull Vibration Analysis**	2	23-27
Dökmeci, M.C. **Dynamic Applications of Piezoelectric Crystals. Part I: Fundamentals**	3	9-20
Spanos, P-T.D. **Digital Synthesis of Response-Design Spectrum Compatible Earthquake Records for Dynamic Analyses**	3	21-30
Dökmeci, M.C. **Dynamic Applications of Piezoelectric Crystals. Part II: Theoretical Studies**	4	15-26
Dökmeci, M.C. **Dynamic Applications of Piezoelectric Crystals. Part III: Experimental Studies**	5	11-22
Hundal, M.S. **Mechanical Signature Analysis**	6	19-26
Trainor, P.G.S., Popplewell, N., Shah, A.H., and Pinkney, R.B. **Static and Dynamic Behavior of Mechanical Components Associated with Electric Transmission Lines**	6	27-38
Chen, S.S. **Instability of Circular Cylinder Arrays in Cross Flow**	7	17-26
Agrawal, B.N. and Evan-Iwanowski, R.M. **Nonstationary Resonance Oscillations**	7	27-33
Iwatsubo, T. **Stability Problems of Rotor Systems**	8	13-24
Mulcahy, T.M. **Leakage of Flow-Induced Vibrations of Reactor Components**	9	11-18
Sierakowski, R.L. and Chaturvedi, S.K. **Impact Loading in Filamentary Structural Composites**	10	13-31

	ISSUE	PAGES
Manolis, G.D. **Dynamic Behavior of Underground Structures**	11	7-18
Nicholson, D.W. and Inman, D.J. **Stable Response of Damped Linear Systems**	11	19-25
Dubey, R.N. and Sahay, C. **Vibration of Overhead Transmission Lines IV**	12	11-15

BOOK REVIEWS

Anderson, H.L., ed., Physics Vade Mecum, American Institute of Physics, New York, NY, 1981; Reviewed by V.R. Miller, SVD, 15 (6), pp 40-41 (June 1983)

Baldock, G.R. and Bridgeman, T., The Mathematical Theory of Wave Motion, Halsted Press, Div. of John Wiley & Sons, New York, NY, 1981; Reviewed by S.K. Datta, SVD, 15 (12), p 16 (Dec 1983)

Bansevičius, R. and Ragulskis, K., Vibromotors, Izd. "Mokslas," Vilnius, Lithuanian SSR, 1981 (in Russian); Reviewed by A. Muszynska, SVD, 15 (4), pp 28-29 (Apr 1983)

Baxa, D.E., ed., Noise Control in Internal Combustion Engines, John Wiley & Sons, New York, NY, 1982; Reviewed by V.R. Miller, SVD, 15 (9), p 19 (Sept 1983)

Besant, C.B., Computer Aided Design and Manufacture, Halsted Press, Div. of John Wiley & Sons, New York, NY, 1980; Reviewed by H. Schaeffer, SVD, 15 (5), pp 23-24 (May 1983)

Besseling, J.F. and Van de Heijden, A.M.A., eds., Trends in Solid Mechanics, Delft University Press, Sijthoff & Noordhoff International, The Netherlands, 1980; Reviewed by R.A. Ibrahim, SVD, 15 (3), pp 32-34 (Mar 1983)

Craig, R.R., Jr., Structural Dynamics -- An Introduction to Computer Methods, John Wiley & Sons, New York, NY, 1981; Reviewed by H. Saunders, SVD, 15 (2), pp 28-29 (Feb 1983)

Craig, R.R., Jr., Structural Dynamics -- An Introduction to Computer Methods, John Wiley & Sons, New York, NY, 1981; Reviewed by R.A. Ibrahim, SVD, 15 (2), pp 29-31 (Feb 1983)

Fader, B., Industrial Noise Control, John Wiley & Sons, New York, NY, 1981; Reviewed by V.R. Miller, SVD, 15 (11), pp 28-29 (Nov 1983)

Ghering, W.L., Reference Data for Acoustic Noise Control, Ann Arbor Science Publ., Ann Arbor, MI, 1980; Reviewed by V.R. Miller, SVD, 15 (9), p 19 (Sept 1983)

Gibbs, H.G. and Richards, T.H., eds., Stress, Vibration and Noise Analysis in Vehicles, Applied Science Publishers Ltd., London, 1975; Reviewed by C.C. Smith, SVD, 15 (6), pp 39-40 (June 1983)

Gould, P.L. and Abu-Sitta, S.H., Dynamic Response of Structures to Wind and Earthquake Loading, Halsted Press, Div. of John Wiley & Sons, New York, NY, 1980; Reviewed by H. Saunders, SVD, 15 (12), pp 16-17 (Dec 1983)

Has'minskii, R.Z. (D. Louvigh, transl. and S. Swierczkowski, ed.), Stochastic Stability of Differential Equations, Sijthoff and Noordhoff, Amsterdam, The Netherlands and New York, NY, 1980; Reviewed by R.A. Ibrahim, SVD, 15 (5), pp 24-25 (May 1983)

Hemond, C.J., Jr., Engineering Acoustics and Noise Control, Prentice-Hall, Inc., Englewood Cliffs, NJ, 1983; Reviewed by R.J. Peppin, SVD, 15 (12), pp 17-18 (Dec 1983)

Henrych, J., The Dynamics of Arches and Frames, Elsevier Scientific Publishing Co., Amsterdam, The Netherlands and New York, NY, 1981; Reviewed by S. Holzer, SVD, 15 (4), p 28 (Apr 1983)

Hutton, D.V., Applied Mechanical Vibrations, McGraw-Hill, New York, NY, 1981; Reviewed by H. Saunders, SVD, 15 (9), pp 20-21 (Sept 1983)

Iotti, R.C. and Bernstein, M.D., eds., Vibration in Power Plant Piping and Equipment, ASME Publ. H00192, New York, NY, 1981; Reviewed by H. Saunders, SVD, 15 (3), pp 34-35 (Mar 1983)

Iyengar, N.G.R. and Gupta, S.K., Programming Methods in Structural Design, Affiliated East-West Press Pvt. Ltd., New Delhi-Madras, 1980; Reviewed by J.S. Rao, SVD, 15 (9), pp 21-22 (Sept 1983)

Kamal, M. and Wolf, J.A., Jr., eds., Modern Automotive Structural Analysis, Van Nostrand Reinhold Co., New York, NY, 1982; Reviewed by R.R. Cook, SVD, 15 (6), p 39 (June 1983)

Leitmann, G., The Calculus of Variations and Optimal Control: An Introduction, Plenum Press, New York, NY, 1981; Reviewed by L.Y. Bahar, SVD, 15 (7), pp 35-36 (July 1983)

Lukasiewicz, S., Local Loads in Plates and Shells, Sijthoff and Noordhoff, Amsterdam, The Netherlands and New York, NY, 1979, Reviewed by H. Saunders, SVD, 15 (5), pp 25-27 (May 1983)

Miller, R.K., Energy and Noise, Fairmont Press, Atlanta, GA, 1981; Reviewed by V.R. Miller, SVD, 15 (10), p 34 (Oct 1983)

Miller, R.K., Montone, W.F., and Oviatt, M.D., Noise Control Solutions for the Wood Products Industry, Fairmont Press, Atlanta, GA, 1980; Reviewed by V.R. Miller, SVD, 15 (7), pp 34-35 (July 1983)

Miller, R.K., Montone, W.V., and Oviatt, M.D., Noise Control Solutions for the Chemical and Petroleum Industry, Fairmont Press, Atlanta, GA, 1980; Reviewed by V.R. Miller, SVD, 15 (8), pp 25-26 (Aug 1983)

Morse, P.M., Vibration and Sound, American Institute of Physics, New York, NY, 1981; Reviewed by R.J. Peppin, SVD, 15 (2), p 31 (Feb 1983)

Mustain, R.W., ed., Advances in Dynamic Analysis and Testing, SAE No. SP-529, Warrendale, PA, 1982; Reviewed by H. Saunders, SVD, 15 (10), p 33 (Oct 1983)

Nemat-Nasser, S., ed., Mechanics Today, Volume 6, Pergamon Press, New York, NY, 1981; Reviewed by L.Y. Bahar, SVD, 15 (7), p 35 (July 1983)

Nowinski, J.L., Applications of Functional Analysis in Engineering, Plenum Press, New York, NY, 1981; Reviewed by L.Y. Bahar, SVD, 15 (11), pp 27-28 (Nov 1983)

Oviatt, D. and Miller, R.K., Industrial Pneumatic Systems: Noise Control and Energy Conservation, Fairmont Press, Atlanta, GA, 1981; Reviewed by V.R. Miller, SVD, 15 (5), p 23 (May 1983)

Perrone, N. and Pilkey, W., eds., Structural Mechanics Software Series IV, University Press of Virginia, Charlottesville, VA, 1982; Reviewed by M.M. Hurwitz, SVD, 15 (4), pp 27-28 (Apr 1983)

Pierce, A.D., Acoustics: An Introduction to Its Physical Principles and Applications, McGraw-Hill, New York, NY, 1981; Reviewed by V.R. Miller, SVD, 15 (7), p 34 (July 1983)

Reynolds, D.D., Engineering Principles of Acoustics: Noise & Vibration Control, Allyn and Bacon, Inc., Boston, MA, 1981; Reviewed by V.R. Miller, SVD, 15 (8), p 25 (Aug 1983)

Ricker, N.H., Transient Waves in Visco-elastic Media, Elsevier-North Holland Pub. Co., New York, NY, 1977; Reviewed by S.K. Datta, SVD, 15 (1), p 32 (Jan 1983)

Robinson, E.A. and Silvia, M.T., Digital Signal Processing and Time Series Analysis, Holden-Day, Inc., San Francisco, CA, 1979; Reviewed by H. Saunders, SVD, 15 (11), p 26 (Nov 1983)

Robinson, E.A. and Silvia, M.T., Digital Foundations of Time Series Analysis -- The Box-Jenkins Approach, Holden-Day, Inc., San Francisco, CA, 1979; Reviewed by H. Saunders, SVD, 15 (11), p 27 (Nov 1983)

Rosenblueth, E., ed., Design of Earthquake Resistant Structures, John Wiley & Sons, New York, NY, 1980; Reviewed by H. Saunders, SVD, 15 (8), pp 27-28 (Aug 1983)

Szeri, A.Z., ed., Tribology -- Friction, Lubrication and Wear, McGraw-Hill, New York, NY, 1980; Reviewed by D. Koshal, SVD, 15 (1), p 31 (Jan 1983)

Thureau, P. and Lecler, D. (J. Grosjean, transl.), An Introduction to the Principles of Vibrations of Linear Systems, John Wiley & Sons, New York, NY, 1981; Reviewed by T.S. Sankar, SVD, 15 (1), p 32 (Jan 1983)

Urick, R.J., Sound Propagation in the Sea, Peninsula Publishers, Los Altos, CA, 1982; Reviewed by M.C. Junger, SVD, 15 (6), p 40 (June 1983)

Vincent, T.L. and Grantham, W.J., Optimality in Parametric Systems, John Wiley & Sons, New York, NY, 1981; Reviewed by K. Huseyin, SVD, 15 (8), pp 27-28 (Aug 1983)

Wait, J.R., Wave Propagation Theory, Pergamon Press, Elmsford, NY, 1981; Reviewed by R.A. Scott, SVD, 15 (10), p 32 (Oct 1983)

Zukas, J., Nicholas, T., Swift, H.F., Greszuk, L.B., and Curran, D.R., Impact Dynamics, John Wiley & Sons, New York, NY, 1982; Reviewed by R.L. Sierakowski, SVD, 15 (3), pp 31-32 (Mar 1983)

Proceedings: Noise and the Environment, National Board for Science and Technology, Dublin, Ireland, 1980; Reviewed by V.R. Miller, SVD, 15 (10), pp 32-33 (Oct 1983)

LIST OF REVIEWERS

Adams, M.L., Jr.
Agrawal, B.N.
Ahlbeck, D.R.
Ali, R.
Arndt, R.E.A.
Attenborough, K.
Bagci, C.
Bahar, L.Y.
Baker, W.E.
Barrett, L.
Beards, C.F.
Beltzer, A.I.
Bernard, J.E.
Bert, C.W.
Blanks, H.S.
Chang, C.H.
Chen, S.S.
Cook, R.D.
Chung, T.J.
Datta, S.K.
De, S.
De Regt, M.J.A.M
DiMaggio, F.L.
Dogan, M.
Dökmeci, M.C.
Done, G.T.S.
Dubey, R.N.
Dungar, R.
Etsion, I.
Etter, P.C.
Fawcett, J.N.
GangaRao, H.V.S.
Genin, J.
Gibson, R.F.
Ginsberg, J.H.
Gopalakrishnan, S.
Gopalan, I.V.
Greif, R.
Griffin, M.J.
Hobaica, E.C.
Holmes, R.
Holzer, S.
Hundal, M.S.
Huseyin, K.
Ibrahim, R.
Ignaczak, J.
Iwatsubo, T.
Jennings, A.
Jensen, J.J.
Johns, D.J.
Jones, D.I.G.
Jones, N
Kalinowski, A.J.
Kelly, J.M.
Krajcinovic, D.
Lalanne, M.
Leis, B.N.
Leissa, A.
Lund, J.W.
McLean, D.
Malanoski, S.
Manolis, G.D.
Markus, S.
Massoud, M.
Matsuzaki, Y.
Mazumdar, J.
Metwalli, S.M.
Migliore, H.
Miller, V.
Milsted, M.G.
Mote, C.D.
Mulcahy, T.M.
Nicholson, D.
Peppin, R.J.
Platzer, M.F.
Plunkett, R.
Popplewell, N.
Rades, M.
Ragulskis, K.
Ramamurti, V.
Rao, D.K.
Rao, J.S.
Rao, S.S.
Reddy, J.N.
Rieger, N.F.
Rizai, M.N.
Romilly, N.
Sallet, D.W.
Sathyamoorthy, M.
Saunders, H.
Scott, R.A.
Sierakowski, R.L.
Singh, R.
Spanos, P.D.
Srinivasan, V.
Stadelbauer, D.
Ting, E.C.
Trainor, P.G.S.
Triantafyllou, M.
Vaičaitis, R.
Vassilopoulos, L.
Waberski, A.
Wambsganss, M.W.
Wittlin, G.

AUTHOR INDEX

A

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

SUBJECT INDEX

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Acoustic Waves

			1013						
			2303						

Acoustical Data
use Experimental Data

Active Control

		1202	1443	74		16		208	2159
								1108	

Active Damping

2280					1235	16	937	1848	1849

Active Flutter Control

280	281	282			2425	1136	1137	278	279
2160						2266		1138	2409

Active Force Control

						2426			

Active Isolation

300		302					937	1758	

Active Vibration Control

1600	721	722	723	2174	1235				79
		1322	893	2224	2175				

Actuators

								2048	

Aerodynamic Characteristics

	921	1562					797		
	1741	1742							

Aerodynamic Damping

					305				2359

Aerodynamic Loads

710	291	842	183	2164	305	66	67	468	459
1130	1981		2413	2354	1095	306	307	728	709
	2431				1165	2136	1767	878	859
							2137	918	919
							2507	1798	1079
								2138	

Aerodynamic Noise

	1141								

Aerodynamic Response
use Aerodynamic Stability

Aerodynamic Stability

	2171	2162	2333	2434					2269

Aeroelasticity

	1751	1352	2163	544		1956	987		
		1382		1934			2027		
				2344					

Agricultural Machinery

			2393						

Air Bags (Safety Restraint Systems)

				1744					

Air Bags (Soft Landing)

			303				717		

Air Blast

			363			586	437		579
			1863				587		

Airborne Equipment Response

720					935				
					1135				

Air Cargo

								718	

Air Compressors
use Compressors

Air Conditioning Equipment

2130			2043		1935	1936			2129
					1995				

Aircraft

70	271	272	273	274	1315	66	67	708	279
270	921	922	283	984	1455	466	1177	1318	709
280	1741	1312	923			1166	1317	1978	859
920	1751		1313			1316	1537	2128	919
1130	2161					1736	1757		1139
1140	2411					2266			1149
1150									1539
1190									1799
1980									2159
2160									2409
2410									

Aircraft Engines

660	1131	672		884		776		1538	2429
1760	1891	932		1134		1656			
				1554		2126			

Aircraft Equipment

						1886			

Aircraft Noise

1310	1561	132	233	464	65	286	287	288	929
1740		1132	463	704	225	296	297	918	1129
1760		1152	1133	884	285	706	707	928	1309
			1153	1154	295	1536	1737	1738	1739
			1923	1544	705	1816	1747		1979
				1924			1797		
							1977		
							2407		

Aircraft Propellers

				284					

Aircraft Response

	1311								

Aircraft Seats

					2165				

Aircraft Vibration

								2408	

Aircraft Wings

	281	282	2163	2164	275	276	277	68	69
		1742			465	1136	1177	278	
		2162			655		1377	1138	
		2352							
		2412							

Air Drop Operations

		72					717		

Airfoils

800		2162		2164	305	366	797	798	159
2270				2414	365	1626	1627	2278	799
				2434			2507		

Airframes

			273						

Airport Noise
use Airports

Airports

				1924		2246	707	928	
							1747		

Air Transportation

								718	

Algorithms

1430			1453						1899
2370			1663						

Aligning
use Alignment

Alignment

1510	2191							498	1699
								2508	

Alloys

810		1032							

Aluminum

1030	1031		283					378	1639
	2081								

Ammunition

					405				

Amplitude Analysis

				2534					

Analog Simulation

						206			639

Angular Speed

									179

Angular Velocity
use Angular Speed

Angular Vibration
use Torsional Vibration

Anisotropic Properties
use Anisotropy

Anisotropy

1700		962		4					

Annular Plates

		762				116			1599

Antennas

	481		1183						469
			2003						

Antifriction Bearings
use Rolling Contact Bearings

Anvils

				574					

Approximate Methods
use Approximation Methods

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2364	2365-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

- B -

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Beam-Plate Systems

	541								

Beams

320	521	522	103	14	105	106	317	318	319
470	751	752	243	104	155	526	517	518	519
520	971	852	523	524	525	746	527	608	749
750	1181	972	753	974	975	976	747	648	1689
970	1461	1052	973	1184	1185	1356	1127	748	2199
1160	1571	1322	1583	1354	1365	1396	1357	1358	2209
1180	1581	1392	1793	1584	1505	1556	1587	1518	
1360	1851	1582		1634	1585	1586	2517	1588	
1580	2021	1792		1794	1675			2208	
1770	2201	2022			1735				
2200	2211	2402			2045				
2210	2411	2422							
2280		2432							
		2452							

Bearings

240	501	502	503	4	495	496	667	88	309
500	621	882	943	494	945	946	947	308	499
620	951	942	953	944	955	956	957	498	729
730	1051	952	1503	954	1345	1346	1057	668	949
950	1651	1782	2533	1344	1565	1566	1167	948	1169
1050	1781	2192		1564	1775	2436	1567	1168	1459
1780	2191				2435		2007	1648	1499
2190							2187	1658	1889
2440							2437	2008	1909
								2188	2009
								2438	2189
								2538	2439

Bellows

			453						

Bells

570				994					

Belt Conveyors

890									

Belts (Moving)

								958	

Bending

	751								

Bernoulli-Euler Method

				524		106	657		

Bevel Gears

	731		1173			2196	87	88	
	2441		2193						

Bibliographies

1150	301	662	613	1694	65	1236	1927	138	1089
2040	771	772	1233	2354	1085	1926		238	1109
	871	872	1693			2256		428	1129
	1131		2353					798	1149
	1301							1088	
	2041							1928	
	2161								

Bifurcation Theory

					1065				
					1765				

Bird Strikes

			923			1166			

Blade Loss Dynamics

2360			2363						2429

Blade Passing Frequency

1090									

Blades

490	491	492	83	84	85	86	307	728	489
940	941	1342	493	1164	305	306	727	1558	939
1340	1341	1562	1163	1554	725	656	1557	1768	1559
1370	1561	1702	1343	1774	1165	716	1647	1778	1769
1560	1771	1772	1553	2184	1555	726	1767		1779
1650	2431	2372	1563	2364	2185	1166	1777		
1770		2432	1653	2414	2225	1556			
2430			1773	2434		1776			
			2433			2006			
						2186			

Blast Effects

							157		

Blast Loads

					455				2069

Blast Resistant Construction
use Blast Resistant Structures

Blast Resistant Design
use Blast Resistant Structures

Blast Resistant Structures

			1833					18	

Blast Response

		2392			1605	1296		118	1299

Blowers

		1892					147		

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2364	2365-2567
Volume 15 Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2364	2365-2567
Volume 15 Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15 Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2364	2365-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2364	2365-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

- D -

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15 Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2364	2365-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15 Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15 Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2364	2365-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15 Issue:	1	2	3	4	5	6	7	8	9	10	11	12

- I -

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15 Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2364	2365-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

- M -

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15 Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2364	2365-2567
Volume 15 Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2364	2365-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

- N -

Noise Generation (cont'd)

1970	1501	2172		2494					2189
1990	1561	2232							
2490	1761	2372							
	1821								
	1941								
	1961								
	1971								
	1991								
	2251								

Noise-Induced Excitation

			1383						
			2253						

Noise Measurement

780	1541	1132	713	464	5	1536	427	918	289
820	2441	1142	2063	1764	285		1747	2168	459
920		2062		2094	565		2247		789
1740					1095		2497		1749
2250					2095				

Noise Meters
use Sound Level Meters

Noise Prediction

		132	1093	2014	225	1826	287	1218	1619
		1962	1923		2015		1977	2128	1829
		2492	2013				2017		2049
			2253						2489

Noise Propagation
use Sound Propagation

Noise Reduction

40	11	42	263	344	25	286	77	38	39
560	41	142	283	564	55	566	157	348	569
790	141	242	1213	1154	1335	996	1217	548	929
1090	671	272	1223	1944	1935	1416	1397	1398	1129
1220	1091	562	1513		1995	1936	1417	1738	1399
1620	1131	932	2493			1946	1507	1948	1559
1760	1321	1092				2066	1737	1968	1779
1940	1611	1202				2126	1797	2058	1939
2060	1941	1952				2246	1827		1949
2390	1951	1992				2496	1847		1979
	2131	2252					1937		2139
	2311	2342					1947		2189
	2351						1957		2249
							1967		
							2057		
							2067		
							2147		

Noise Source Identification

1950	351	242	1613		565			2058	9
2300			2253		615				1879
					2495				

Noise Transmission

				704				568	1999

Nonconservative Forces

				1064					

Noncontacting Probes
use Proximity Probes

Nondestructive Testing
use Nondestructive Tests

Nondestructive Tests

1650	771	772		2104		1906	1927	1928	189
2320	831	872				1926			
	871	2102							

Nonlinear Analysis
use Nonlinear Theories

Nonlinear Damping

410			2284						

Nonlinear Dynamic Absorbers

		2422							

Nonlinear Response

740	821			214				1118	749

Nonlinear Systems

	591	2122	1353			1666	857	598	229
	1041		1433					638	
	1671								

Nonlinear Theories

1480	211	212	413		105				2269
2440	661	1672	2343		315				
			2363		905				

Nonlinear Vibration

2560	2551		423	994		426	1587	318	2559
							2267		

Normal Density Functions

	641								

Normal Modes

1830			873				247		
2240							787		

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2364	2365-2567
Volume 15 Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2364	2365-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

- U -

- V -

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2587
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15												
Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15 Issue:	1	2	3	4	5	6	7	8	9	10	11	12

Abstract Numbers:	1-238	239-429	430-662	663-873	874-1089	1090-1278	1279-1497	1498-1695	1696-1929	1930-2134	2135-2354	2355-2567
Volume 15 Issue:	1	2	3	4	5	6	7	8	9	10	11	12

CALENDAR

FEBRUARY 1984

22-24 IAVD Congress on Vehicle Component Design [IAVD] Geneva, Switzerland *(Dr. M.A. Dorgham, International Association for Vehicle Design, The Open University, Walton Hall, Milton Keynes MK7 6AA - (0908) 653945.*

27-Mar 2 International Congress and Exposition [SAE] Detroit, MI *(SAE Hqs.)*

MARCH 1984

13-15 12th Symposium on Explosives and Pyrotechnics [Applied Physics Lab. of Franklin Research Center] San Diego, CA *(E&P Affairs, Franklin Research Center, Philadelphia, PA 19103 - (215) 448-1236)*

20-23 Balancing of Rotating Machinery Symposium [Vibration Institute] Philadelphia, Pennsylvania *(Dr. Ronald L. Eshleman, Director, The Vibratin Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254)*

APRIL 1984

9-12 Design Engineering Conference and Show [ASME] Chicago, IL *(ASME Hqs.)*

9-13 2nd International Conference on Recent Advances in Structural Dynamics [Institute of Sound and Vibration Research] Southampton, England *(Dr. Maurice Petyt, Institute of Sound and Vibration Research, The University of Southampton, S09 5NH, England - (0703) 559122, Ext. 2297)*

30-May 3 Institute of Environmental Sciences' 30th Annual Technical Meeting [IES] Orlando, FL *(IES, 940 E. Northwest Hwy., Mt. Prospect, IL 60056 - (312) 255-1561)*

MAY 1984

1-3 Mechanical Failures Prevention Group 38th Symposium [National Bureau of Standards, Washington, D.C.] Gaithersburg, MD *(Dr. J.G. Early, Metallurgy Division, Room A153, Bldg. 223, National Bureau of Standards, Washington, D.C. 20234)*

7-10 30th International Instrumentation Symposium [Instrument Society of America] Denver, CO *(Robert Jarvis, Grumman Aerospace Corp., Mail Stop T01-05, Bethpage, NY 11714)*

7-11 Acoustical Society of America, Spring Meeting [ASA] Norfolk, VA *(ASA Hqs.)*

10-11 12th Southeastern Conference on Theoretical and Applied Mechanics [Auburn University] Callaway Gardens, Pine Mountain, GA *(J. Fred O'Brien, Director, Engineering Extension Service, Auburn University, AL 36849 - (205) 826-4370)*

JUNE 1984

26-28 Machinery Vibration Monitoring and Analysis Meeting [Vibration Institute] New Orleans, LA *(Dr. Ronald L. Eshleman, Director, The Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254)*

JULY 1984

21-28 8th World Conference on Earthquake Engineering [Earthquake Engineering Research Institute] San Francisco, CA *(EEPI-8WCEE, 2620 Telegraph Avenue, Berkeley, CA 94704)*

AUGUST 1984

6-9 West Coast International Meeting [SAE] San Diego, CA *(SAE Hqs.)*

19-25 XVIth International Congress on Theoretical and Applied Mechanics [International Union of Theoretical and Applied Mechanics] Lyngby, Denmark *(Prof. Frithiof Niordson, President, or Dr. Niels Olhoff, Executive Secretary, ICTAM, Technical University of Denmark, Bldg. 404, Dk-2800 Lyngby, Denmark)*

SEPTEMBER 1984

9-11 Petroleum Workshop and Conference [ASME] San Antonio, TX *(ASME Hqs.)*

11-13 Third International Conference on Vibrations in Rotating Machinery [Institution of Mechanical Engineers] University of York, UK *(IMechE Hqs.)*

30-Oct 4 Power Generation Conference [ASME] Toronto, Ontario, Canada *(ASME Hqs.)*

OCTOBER 1984

8-12 Acoustical Society of America, Fall Meeting [ASA] Minneapolis, MN *(ASA Hqs.)*

CALENDAR ACRONYM DEFINITIONS AND ADDRESSES OF SOCIETY HEADQUARTERS

AHS: American Helicopter Society
1325 18 St. N.W.
Washington, D.C. 20036

AIAA: American Institute of Aeronautics and Astronautics
1290 Sixth Ave.
New York, NY 10019

ASA: Acoustical Society of America
335 E. 45th St.
New York, NY 10017

ASCE: American Society of Civil Engineers
345 E. 45th St.
New York, NY 10017

ASME: American Society of Mechanical Engineers
345 E. 45th St.
New York, NY 10017

ASTM: American Society for Testing and Materials
1916 Race St.
Philadelphia, PA 19103

ICF: International Congress on Fracture
Tohoku University
Sendai, Japan

IEEE: Institute of Electrical and Electronics Engineers
345 E. 47th St.
New York, NY 10017

IES: Institute of Environmental Sciences
940 E. Northwest Highway
Mt. Prospect, IL 60056

IMechE: Institution of Mechanical Engineers
1 Birdcage Walk, Westminster,
London SW1, UK

IFToMM: International Federation for Theory of Machines and Mechanisms
U.S. Council for TMM
c/o Univ. Mass., Dept. ME
Amherst, MA 01002

INCE: Institute of Noise Control Engineering
P.O. Box 3206, Arlington Branch
Poughkeepsie, NY 12603

ISA: Instrument Society of America
400 Stanwix St.
Pittsburgh, PA 15222

SAE: Society of Automotive Engineers
400 Commonwealth Drive
Warrendale, PA 15096

SEE: Society of Environmental Engineers
Owles Hall, Buntingford, Hertz.
SG9 9PL, England

SESA: Society for Experimental Stress Analysis
14 Fairfield Drive
Brookfield Center, CT 06805

SNAME: Society of Naval Architects and Marine Engineers
74 Trinity Pl.
New York, NY 10006

SPE: Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, TX 75206

SVIC: Shock and Vibration Information Center
Naval Research Lab., Code 5804
Washington, D.C. 20375

PUBLICATION POLICY

Unsolicited articles are accepted for publication in the Shock and Vibration Digest. Feature articles should be tutorials and/or reviews of areas of interest to shock and vibration engineers. Literature review articles should provide a subjective critique/summary of papers, patents, proceedings, and reports of a pertinent topic in the shock and vibration field. A literature review should stress important recent technology. Only pertinent literature should be cited. Illustrations are encouraged. Detailed mathematical derivations are discouraged; rather, simple formulas representing results should be used. When complex formulas cannot be avoided, a functional form should be used so that readers will understand the interaction between parameters and variables.

Manuscripts must be typed (double-spaced) and figures attached. It is strongly recommended that line figures be rendered in ink or heavy pencil and neatly labeled. Photographs must be unscreened glossy black and white prints. The format for references shown in DIGEST articles is to be followed.

Manuscripts must begin with a brief abstract, or summary. Only material referred to in the text should be included in the list of References at the end of the article. References should be cited in text by consecutive numbers in brackets, as in the example below.

> Unfortunately, such information is often unreliable, particularly statistical data pertinent to a reliability assessment, as has been previously noted [1].
>
> Critical and certain related excitations were first applied to the problem of assessing system reliability almost a decade ago [2]. Since then, the variations that have been developed and the practical applications that have been explored [3-7] indicate that . . .

The format and style for the list of References at the end of the article are as follows:

- each citation number as it appears in text (not in alphabetical order)
- last name of author/editor followed by initials or first name
- titles of articles within quotations, titles of books underlined
- abbreviated title of journal in which article was published (see Periodicals Scanned list in January, June, and December issues)
- volume, number or issue, and pages for journals; publisher for books
- year of publication in parentheses

A sample reference list is given below.

1. Platzer, M.F., "Transonic Blade Flutter - A Survey," Shock Vib. Dig., 7 (7), pp 97-106 (July 1975).
2. Bisplinghoff, R.L., Ashley, H., and Halfman, R.L., Aeroelasticity, Addision-Wesley (1955).
3. Jones, W.P., (Ed.), "Manual on Aeroelasticity," Part II, Aerodynamic Aspects, Advisory Group Aeronaut. Res. Devel. (1962).
4. Lin, C.C., Reissner, E., and Tsien, H., "On Two-Dimensional Nonsteady Motion of a Slender Body in a Compressible Fluid," J. Math. Phys., 27 (3), pp 220-231 (1948).
5. Landahl, M., Unsteady Transonic Flow, Pergamon Press (1961).
6. Miles, J.W., "The Compressible Flow Past an Oscillating Airfoil in a Wind Tunnel," J. Aeronaut. Sci., 23 (7), pp 671-678 (1956).
7. Lane, F., "Supersonic Flow Past an Oscillating Cascade with Supersonic Leading Edge Locus," J. Aeronaut. Sci., 24 (1), pp 65-66 (1957).

Articles for the DIGEST will be reviewed for technical content and edited for style and format. Before an article is submitted, the topic area should be cleared with the editors of the DIGEST. Literature review topics are assigned on a first come basis. Topics should be narrow and well-defined. Articles should be 1500 to 2500 words in length. For additional information on topics and editorial policies, please contact:

Milda Z. Tamulionis
Research Editor
Vibration Institute
101 W. 55th Street, Suite 206
Clarendon Hills, Illinois 60514

DEPARTMENT OF THE NAVY

NAVAL RESEARCH LABORATORY, CODE 5804
SHOCK AND VIBRATION INFORMATION CENTER
Washington, DC 20375

DEFENSE DOCUMENTATION CENTER
CAMERON STATION
ALEXANDRIA, VA 22314

THE SHOCK AND VIBRATION DIGEST

Volume 15, No. 12 December 1983

Partial contents:

EDITORIAL

ARTICLES AND REVIEWS

CURRENT NEWS

ABSTRACTS FROM THE CURRENT LITERATURE ; and

ANNUAL INDEXES

CALENDAR